

# **SECTION 1.0**

## **WALLOPS FLIGHT FACILITY**

### **RANGE CAPABILITIES**

#### **1.1 GENERAL INFORMATION**

##### **1.1.1 Local Area and Local Population Information**

The Wallops Flight Facility (WFF) is located on Virginia's Eastern Shore at Wallops Island, Virginia. The northern border of the WFF launch site is the Chincoteague Inlet, which separates Wallops Island from the Chincoteague and Assateague Islands. These islands contain the town of Chincoteague, located about 3.9 NM from the launch site with a population of around 2,000, the Assateague National Seashore operated by the National Park Service, and a National Wildlife Refuge operated by the Fish and Wildlife Service. On both the east and south, the launch site is bounded by the Atlantic Ocean. On the west, it is adjacent to the Bogues, Powells, and Watts Bays, salt water marshes, and agricultural land. In addition, the sparsely populated towns of Assawoman and Atlantic, with populations of roughly 150 and 325 respectively, are located approximately 3.2 NM from the launch site, and Pocomoke City, MD, with a population of 4,000, is situated approximately 13 NM northwest.

##### **1.1.2 WFF Range History/General Capabilities**

In 1945, the National Advisory Committee for Aeronautics (NACA) established a launch site on Wallops Island, Virginia, under the direction of the Langley Research Center, then a field laboratory station of NACA. This site was designated the Pilotless Aircraft Research Station and assigned the mission of conducting research to supplement wind tunnel and laboratory investigations into the problems of flight. When Congress established the National Aeronautics and Space Administration (NASA) in 1958, (and absorbed Langley Research Center and other NACA field centers and research facilities), the Pilotless Aircraft Research Station became a separate facility - Wallops Station - operating directly under NASA Headquarters in Washington, D.C. It became Wallops Flight Center in 1974, and the name was changed to Wallops Flight Facility (WFF) in 1981 when it was incorporated into the Goddard Space Flight Center (GSFC), Greenbelt, Maryland.

Since 1945, there have been more than 14,000 suborbital and orbital research vehicles (sounding rockets, research aircraft, and research balloons) launched from or managed by the WFF by various launching agencies to obtain information on the flight characteristics of airplanes, launch vehicles, and spacecraft; and to increase

knowledge of the Earth's upper atmosphere and the near-space environment. Several hundred experiments have been launched each year. Launch vehicles used have varied in size and power from the small Super Loki meteorological rocket to the four-stage Scout vehicle with orbital capability. Twenty-one orbital satellites were launched on the Scout vehicle from WFF. An additional 19 suborbital Scouts were launched carrying probes and simulated reentry experiments.

WFF evaluates each launch vehicle on a case-by-case basis. Vehicle type and size is limited principally by WFF range launch danger area restrictions. Vehicles launched from WFF can provide a low earth orbit payload capability of up to approximately 8,000 pounds at altitudes ranging from approximately 100 NM to 700 NM. However, range users contemplating launch from WFF must coordinate directly with range representatives to determine WFF's capability to support their particular launch vehicle. Limitations are due mainly to the lack of storage facilities for liquid fuels (plans are to expand this capability in the future as mission requirements dictate), launch danger areas that reflect vehicle performance, and consideration of impact areas of spent, separated stages. In addition to launch support capabilities, WFF has extensive tracking and data acquisition capabilities in three functional areas: radar, telemetry, and data systems, including communications and optics. Activities in these areas support the full range of rocket, balloon, aeronautical research and development, and scientific experimentation. Similar capabilities can be configured to support mobile operations worldwide. In addition, WFF owns and operates a satellite tracking facility as an integral part of the facility telemetry capability.

### **1.1.3 WFF Organization (SPOD)**

The organizational flow from the GSFC to the Wallops Flight facility is shown in Figure 1-1. The Suborbital Projects and Operations Directorate (SPOD) is a first line directorate in the Goddard Space Flight Center Organization. The Director of Suborbital Projects and Operations exercises overall jurisdiction and is responsible for all GSFC/WFF operations. The SPOD's organization, which consists of three staff and seven line elements, is shown in Figure 1-2. The Policy and Business Relations Office, a staff element, is the initial point of contact for commercial agencies that wish to launch from WFF. The other two staff elements *are* the Safety Office and the Resource Management Office. The line elements are the Sounding Rocket Program Office, Balloon Program Office, Aircraft Office, Range and Mission Management Office, University Class Projects Office, Spartan Projects Office and the Shuttle Small Payload Projects Office.

The Suborbital Projects & Operations Directorate is responsible for:

- Managing and directing the NASA Sounding Rocket Program and the NASA Balloon Program.

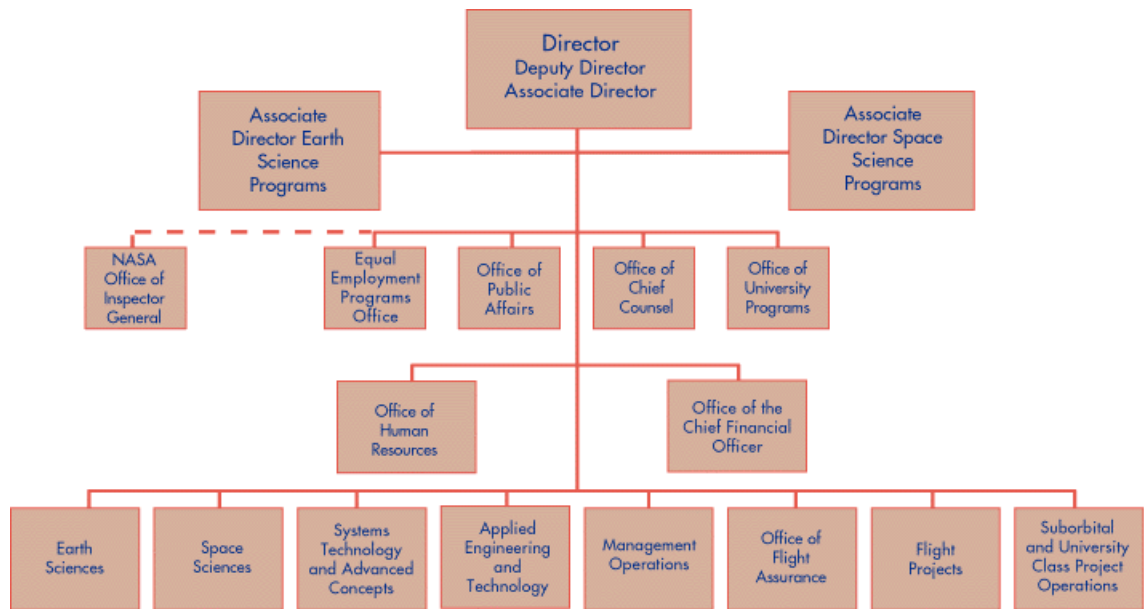


Figure 1 - 1: Goddard Space Flight Center (GSFC) Organization



## Goddard Space Flight Center Wallops Flight Facility

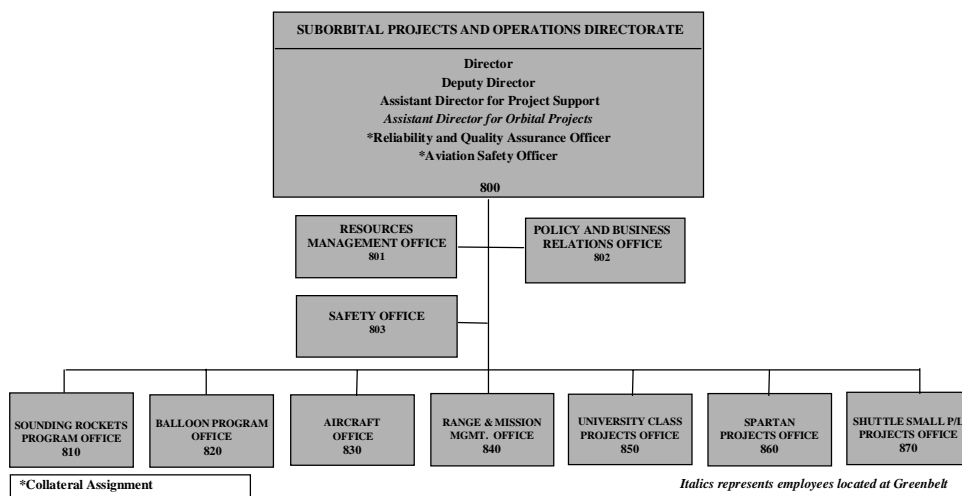


Figure 1 - 2 Suborbital Projects and Operations Directorate

- Providing mission management and payload design, development, fabrication and testing; experiment management support; launch operations; coordination of tracking and data acquisition; engineering and operational support, and technical skills required to conduct aerospace, and other project operations at Wallops and other locations around the world.
- Providing the project interface with NASA Headquarters, Program Offices, other government agencies, universities, private industry, and the international community.
- Planning and conducting launches of scientific payloads and aeronautical tests and other research development and related activities as requested by elements of NASA, the Department of Defense, private industry, other agencies and the worldwide scientific community.
- Maintaining and operating research facilities that include a range, research airport, and program support aircraft on a worldwide basis.
- Managing the National Scientific Balloon Facility in Palestine, Texas, and Ft. Sumner, New Mexico.
- Planning, managing, implementing, and evaluating of the Directorate's space launch commercialization programs. Seeking to match Directorate capability to national and international needs.
- Facilitating the transfer of new knowledge and aerospace technology from Wallops programs into the public and private sectors.
- Implementing educational outreach programs to share knowledge of and participation in Wallops mission programs with colleges, universities, high schools, and the general public.
- Providing management and operations support for assigned research and technology projects.
- Functions as the senior official on site at Wallops and assumes the ultimate responsibility or the safe conduct of all missions at Wallops.

#### **1.1.3.1 Safety Office**

The Safety Office is responsible for:

- Planning, developing, and providing functional management of policies and procedures for ground and flight safety, mission assurance, reliability and quality assurance.
- Performing engineering analysis of ground and flight safety systems, environmental conditions, and operating activities to assure safety reliability and flight worthiness..

- Establishing and approving safety precautions for protection of personal property and the public from hazards generated by ground and flight systems.
- Providing preflight and postflight analysis for flight missions.
- Providing multi-disciplinary engineering laboratories that support calibration standards and other for all types of electrical, electronic, electromechanical, and mechanical instrumentation
- Maintaining Wallops calibration standards and performs a wide variety of analyses on propellants, fuels, hydraulic fluids, and other similar chemicals.
- Providing services for all Wallops managed projects, both locally and at remote locations.
- Implementing the Wallops institutional safety program and manages the base fire department.
- Providing payload safety monitoring and reporting for the orbital projects including the UNEX, Shuttle Small Payloads Projects, and the Spartan Projects. This includes interfacing with the Office of Flight Assurance, KSC, and the JSC safety organizations.
- Providing reliability and quality assurance support for all WFF offices and missions.

#### **1.1.3.2 Range and Mission Management Office**

The Range and Mission Management Office is responsible for:

- Providing engineering, technical, and supporting skills necessary to plan, manage, and conduct aerospace and other project operations at Wallops and other locations.
- Planning and directing Wallops efforts to maintain and operate research facilities including the range, research airport program support aircraft, and the Wallops Orbital Tracking Station.
- Planning, organizing, and directing the NASA Sounding Rocket Program, the NASA Balloon Program, and other Lighter-Than-Air Program activities; providing program interface with NASA Headquarters, other government agencies, universities, private industry, and the international community.
- Providing mission and payload management for most of the programs' flight projects.
- Providing engineering support and management to the Balloon and Lighter-Than-Air Program activities, including management of the National Scientific Balloon Facility, feasibility studies, design studies, flight vehicles and systems development, test and evaluation, and data analysis and reporting.

- Managing the NASA university grants and contracts for assigned principal investigators supported by the Sounding Rocket and Balloon Programs.

#### **1.1.4 WFF Test Range**

The location of WFF in relation to nearby major population centers is shown in Figures 1-3, 1-4, and 1-5. It consists of three separate sections of real property:

**Main Base** - Administrative offices, technical service support shops, a rocket inspection and storage area, and an experimental research airport are located at the Main Base. In addition, there are such operational facilities as the Wallops Integrated Control Center (WICC), the main telemetry building, a large computer complex, and tracking and surveillance radars.

**Wallops Island Launching Site** - Wallops Island, a barrier island named after 17<sup>th</sup> century surveyor John Wallop, is located on the coast of Virginia approximately seven miles southeast of the Main Base. Separated from the mainland by two miles of marsh and inland waterway, the island launch site is approximately 7.0 NM long, 0.4 NM wide, and encompasses nearly 1,200 acres of real estate. It is connected with the Mainland by a causeway and bridge. Located on the island are launch sites, assembly shops, blockhouses, dynamic balancing facilities, some rocket storage buildings, and related facilities, several tracking radar's, and Navy Tenant Facilities (e.g. Aegis).

**Wallops Mainland** - The Wallops Mainland, a 0.5 NM strip at the opposite end of the causeway behind the island, is the location for the tracking and scientific radars, communications transmitter facilities, and command transmitters.

#### **1.1.5 WFF Commercial Program Documentation**

Potential commercial WFF range users make initial contact with the Policy and Business Relations Office. The range user provides information (normally a briefing with supporting data) regarding the type of mission to be flown, launch vehicle, payload, schedule, and planned range support requirements. The range representative in turn provides the potential range user with feedback as to whether the range can support their request and whether the proposed project falls under the purview of the Commercial Space Launch Act of 1984 (questions on license requirements should be discussed with the Associate Administrator for Commercial Space Transportation (AST)). Once it has been determined that WFF capabilities can accommodate user requirements, the established process for commercial activities to be performed at WFF is enacted. Documentation to implement the Commercial Space Launch Act (CSLA) within the WFF follows the flow depicted in Figure 1-6.

Wallops Flight Facility documentation requirements for user activities that fall under the provisions of the Commercial Space Launch Act are divided into three

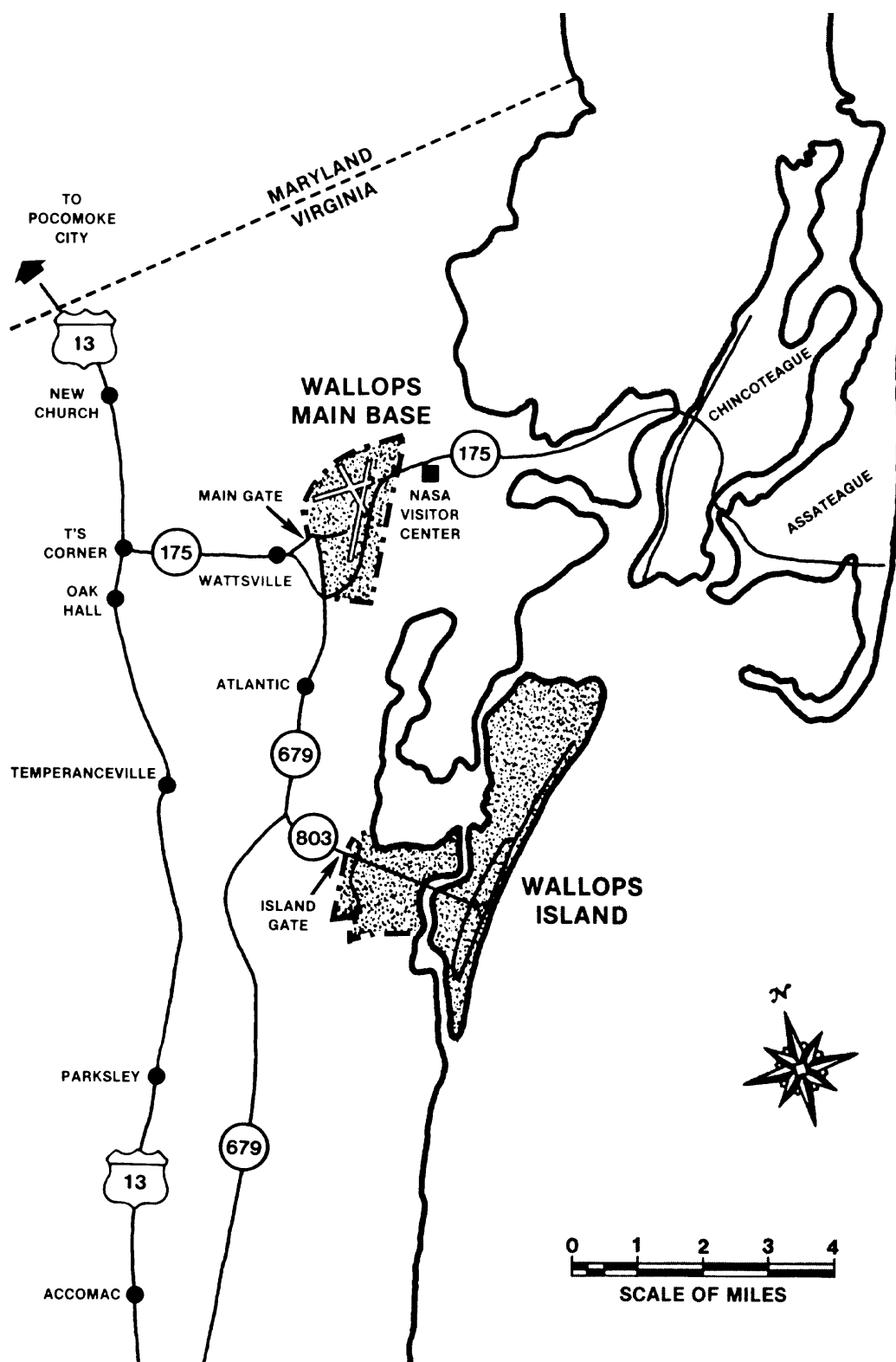


Figure 1 - 3: Wallops Overall

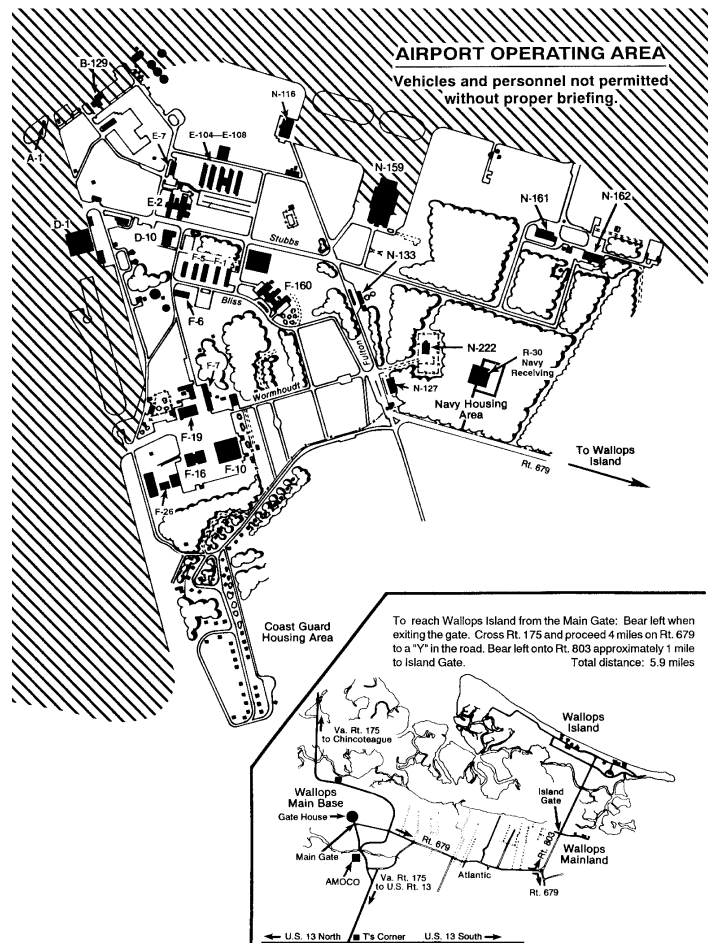


Figure 1 - 4: Wallops Main Base

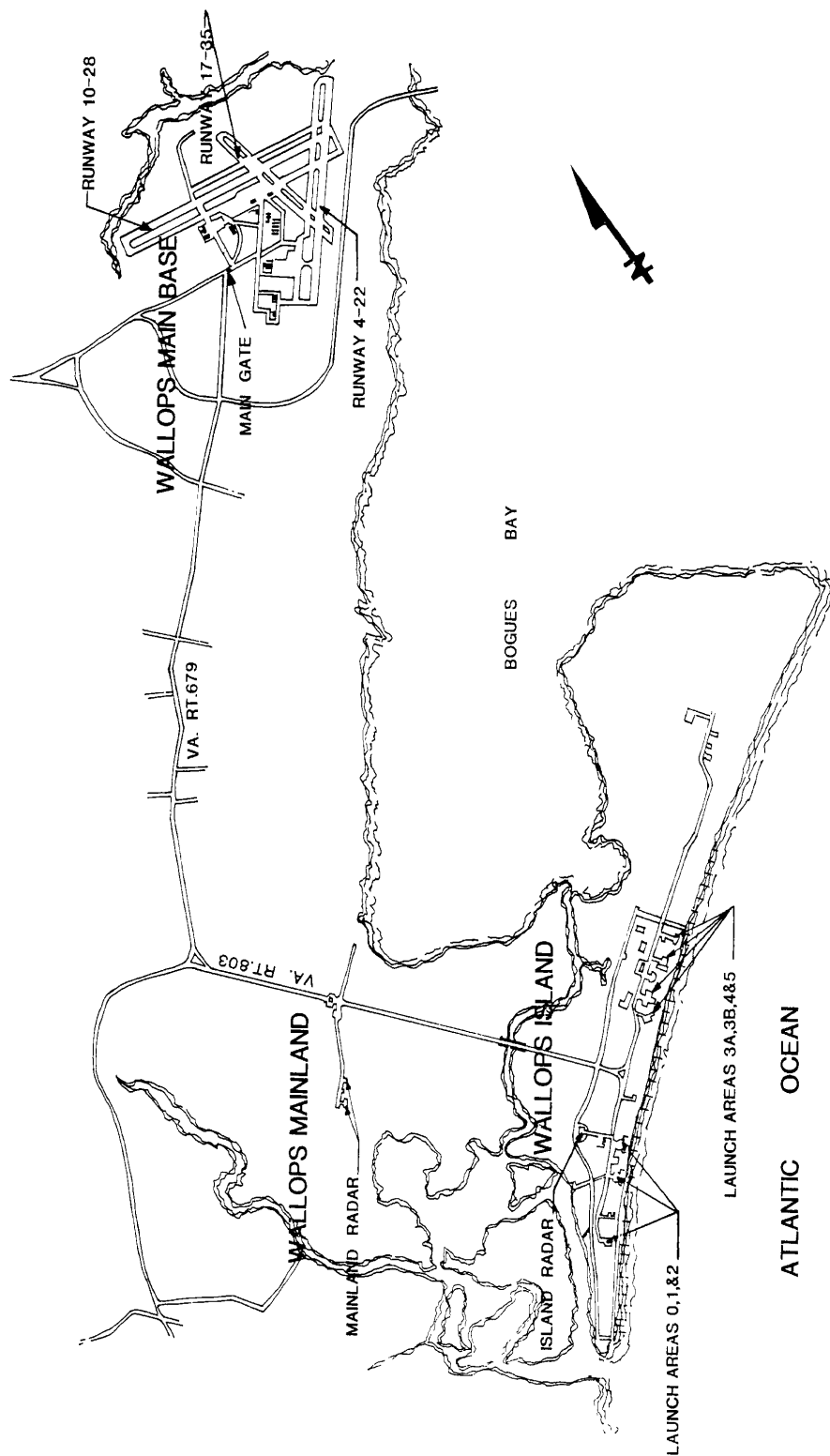
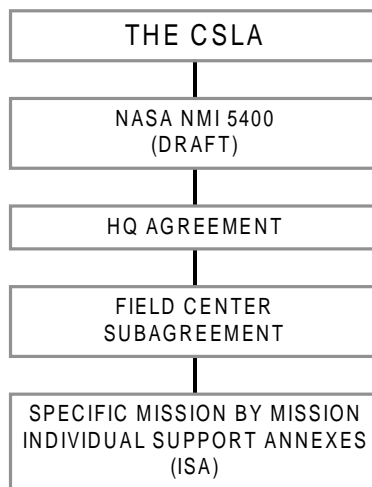


Figure 1 - 5: Wallops Island



**Figure 1 - 6: Commercial Space Launch Act Implementation**

categories: agreements, requirements and interface documents. These documents define the support requirements for the Wallops Flight Facility and provide descriptive information to assist Wallops personnel in assuring requirements are satisfied satisfactory. Other forms of documentation related to safety provide the necessary data to safety office personnel to evaluate potential operational hazards and mission risk. The two types of documentation employed at WFF to promulgate policy, requirements, and response to both administrative and operational considerations are the HQ CSLA Agreement and the GSFC CSLA Sub-agreement. As a result of CLSA agreements established with the Virginia Commercial Space Flight Authority (VCSPA), a user may choose to become a customer of the VCSPA rather than establish a direct relationship with NASA. These documents are briefly discussed in the following paragraphs.

#### **1.1.5.1 HQ CSLA Agreement**

The HQ CSLA Agreement is a support agreement that is required between the potential commercial user and NASA Headquarters. This document is normally in effect for a period of five years after it is signed. However, there are provisions for renewal and extensions. The Agreement sets basic NASA policy and calls for a Subagreement at the GSFC, but does not commit the range user to proceed further. The Agreement is signed by a Headquarters NASA representative and the President, Chief Executive Officer or other corporate level representative of the commercial entity entering into the agreement who is authorized to commit corporate resources. The format of a typical Agreement is as follows:

- Scope and Authority
- Responsibilities
- Security

- Use of Government-Owned, NASA -Controlled Property and Services
- Financial Arrangements
- Allocation of Risks
- Patent and Data Rights
- Termination
- Disputes
- Priority and Delay
- Applicable Law
- Services Consistent with U. S. Laws and Policies
- Assistance with Claims
- Assistance of Rights
- Officials not to Benefit
- Revision Of Agreement
- Notices
- Approval

#### **1.1.5.2 GSFC CSLA Subagreement**

The GSFC CSLA Subagreement is an agreement required between the commercial user and GSFC. This document is in force for a period corresponding to that of the NASA Headquarters agreement. The subagreement also sets basic GSFC and WFF policy, and calls for Individual Support Annexes (ISA) with WFF, but does not commit the range user to proceed further. This subagreement is signed by the Director, Goddard Space Flight Center (see Figure 1-1) and a company representative for the commercial launch vehicle program, and is coordinated with NASA Headquarters. Once approved, the subagreement authorizes the user to visit the field center (WFF) and establish official contact with field center personnel, e.g., the Policy and Business Relations Office (see Figure 1-2), and operations and safety personnel. The format of a typical subagreement is as follows:

- Scope and Authority
- Acknowledgments and Understandings
- Use of Government Facilities and Services
- Support Requirements
- Environmental Issues
- Safety
- Financial Arrangements
- Revision and Termination

- Public Information
- Effective date and Duration
- Financial Status Report

#### **1.1.5.3 Enabling and Operational Documentation**

Enabling documentation such as annexes, requirements, directives, and plans provide the basis for establishing needs and support responses for the program ground processing and flight operations. Individual Support Annexes (ISA's) between WFF and the user are administered by the Policy and Business Relations Office. ISA's are mission-specific operational tools that describe the user's needs and NASA support. These annexes are signed by the WFF Director of Suborbital Projects and Operations, and the commercial company representative. At this point, a range support manager from the Range & Mission Management Office is assigned to the mission and becomes the range interface. There are five distinct ISAs; however, only those needed are implemented. The five ISAs and their associated operations documentation include:

- a. ISA Task A covers Pre-mission Feasibility Planning, Range Support Analysis, and Cost Estimation Analysis. This ISA is implemented for those situations where the commercial user does not have a specific mission but does need to interface with WFF. All costs for this support are the user's responsibility. Some examples include range safety studies to determine launch feasibility, operational studies, travel to planning meetings, or cost estimation in preparation for a proposal.
- b. ISA Task B covers support of the (Launch Company Name) commercial space launch of (Payload Name or Payload Company Name) satellite or sub-orbital payload. This ISA is implemented to cover support for each launch/mission to be conducted by WFF. It is used for all launch activities at WFF and all mobile missions. This support includes but is not limited to a schedule of facility use, schedule of field activities, PRD, schedule of insurance coverage, FAA launch license, frequency utilization plan, gross hazards analysis, flight safety data, ground safety data package, hazardous procedures package, and FTS test reports for vehicles such as Pegasus or other innovative launch concepts/programs. These programs may require off-range system support and/ or coordination with other ranges or non governmental interests. The full range of facilities, instrumentation, and services that are available are described in this ISA
- c. ISA Task C covers NASA support of launches from established launch sites external to WFF, e.g. Alaska, Brazil. It includes rockets and other vehicles/payloads being launched by US Companies subject to the CSLA from an external launch site/range. This ISA is an abbreviated version of the Task B

ISA. This ISA is intended to be used to cover NASA support activities that involve multiple support agencies and launches at locations external to WFF.

d. ISA Task D covers Public Affairs. Task D is a joint plan on how public affairs will be accomplished for all missions, participants, and launch locations.

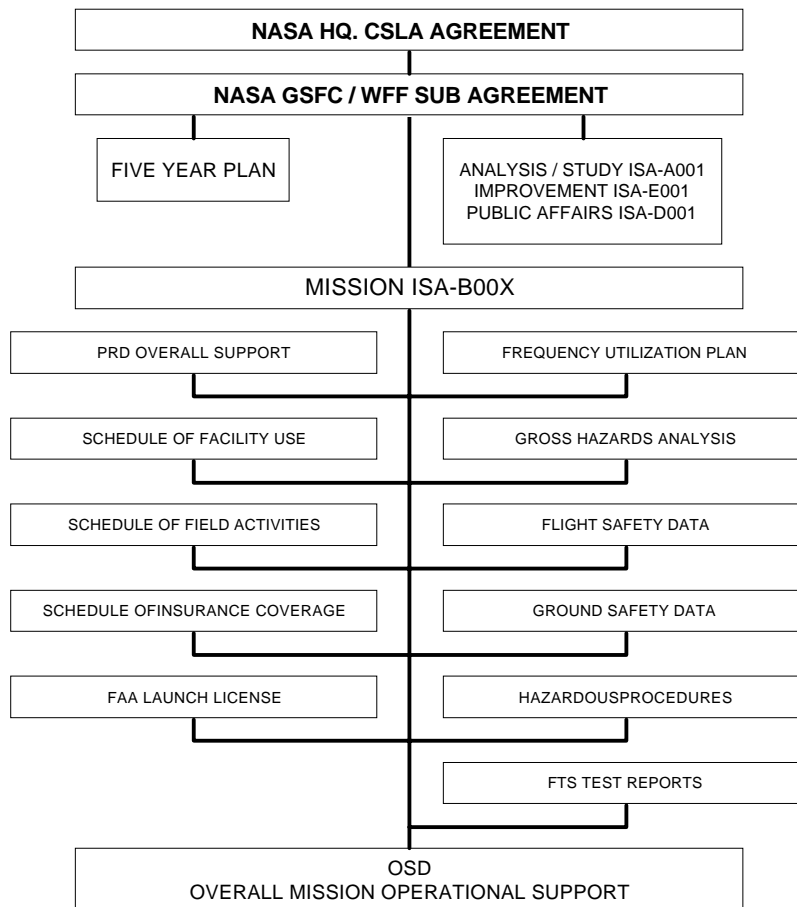
e. ISA Task E covers Improvement of Facilities. This ISA is used only if NASA facilities are to be modified, or new facilities constructed on NASA property with funding by the commercial user. In order to implement Task E, an Annex or Addendum to the CLSA agreement must be instituted.

f. Program Requirements Document (PRD) is a detailed, full-program, planning document normally required for complex or long lead-time programs. When prepared by the user in accordance with the Universal Documentation System Handbook and submitted to GSFC, it meets the Mission Support Proposal section requirements of the subagreement. The document details the WFF support requirements desired for each mission. In addition to describing the requested support, the PRD provides additional technical information and project descriptions.

g. Mission Frequency Utilization Plan is a detailed plan prepared in accordance with section 4.4 of the ISA TASK B00X series of documents. It is the controlling document for all the frequencies required to conduct the mission (radar, telemetry, command destruct, and radio communications). A draft is due approximately 120 days before support is required and the final document is due 15 days before the mission takes place.

h. Operations and Safety Directive (OSD) is prepared and signed by the Range Support Manager for each launch operation in accordance with the GSFC/WFF Range Safety Manual for that launch. The OSD includes a description of the operation being performed; support requirements; Go/No Go requirements; aviation, ground, and flight safety plans; special operational procedures; and countdown procedures. It is approved by the Chief of the Safety Office and the Chief of the Range and Mission Management Office. It is then published by GSFC/WFF and delivered not later than 21 days prior to the operation.

The agreements described above and some of the other pre-mission enabling documents are unique to CSLA activities while the operational requirements documents are standard for any range user at GSFC/WFF. Figure 1-7 is a flow chart showing the various documents and their relationships.



**Figure 1 - 7: Typical Commercial Launch Support Requirements Flow**

## 1.2 RANGE DESCRIPTION

The Wallops Launch Range originates on Wallops Island, Virginia, and extends out into the Atlantic Ocean. Figure 1-8 shows the near coastal area and the operational impact area associated with WFF launches, while Figure 1-9 shows ground traces for orbital launches into inclinations of 38° or 60°. The principal Wallops Island facilities and launch sites are used to process, check-out, and launch rocket boosters that carry payloads on sub-orbital or low earth orbit trajectories.

### 1.2.1 Complexes and Facilities

The types of complexes and facilities located at WFF include launch pads, launchers, blockhouses, booster preparation and payload check-out buildings, dynamic balance equipment, a timing facility, wind measuring devices, communications and control instrumentation, TV and optical tracking stations, surveillance and tracking radar units, tenant and other supporting facilities. Hazardous materials storage is also available for rocket motors and chemicals.

Acreage is available for future construction to support launch vehicles with alternative propulsion systems, such as liquid or hybrid systems. In general, launch pads are located on the South part of the island in order to provide flexibility in supporting various mission flight azimuths.

The Wallops Island launch complexes and facilities are located adjacent to the beach (see Figure 1-10 for WFF complex and facility locations). Descriptions of inactive areas, active commercial pads, and facilities are included in the following paragraphs:

M-16 and M-20 - These are processing facilities located to the North of the E/W runway. The specific area is located in the lower left corner of Figure 1-4 just to the left of the runway in the band of trees. M-16 is a payload processing facility with two clean rooms (Figure 1-11) and M-20 is used for Pegasus launch vehicle processing (Figure 1-12).

Launch Area Number 0A - Approximately 1,200 feet north of pad 0B and just north of Blockhouse Zero (Z-40) is the new CONESTOGA complex (see Figure 1-10). This launch site consists of a pad and a transportable service structure (see Figures 1-13 and 1-14). The service structure is a modular design capable of being broken down and transported to any site with an appropriate concrete slab. Blockhouse Z-40 (Figure 15) is used as the terminal building for the CONESTOGA launcher. The terminal building serves as the locus of all circuits interfacing with the pad and vehicle as well as a support building for staff and monitoring equipment until evacuation of the launch hazard area is required. The blockhouse covers ~1,830 ft<sup>2</sup>. It has two bays and two equipment rooms that can also be used as office space (see Figure 1-15) when safety allows.

Launch Area Number 0B - Launch Area 0B is located on the southern end of Wallops Island (see Figure 1-10) and is currently designated as the Virginia Commercial Space Flight Authority launch facility. It includes the universal expendable launch vehicle launch mount and several small utility buildings. Reactivation of the site for use by the Virginia Commercial Spaceport Authority is currently under consideration.

The Z-41 facility is located on the South end of the island adjacent to Pad 0A (See Figure 1-10). It was formally used as the Naval Surface Weapons Center Combat System Performance Test Facility. Its three floors have a total area of 8,275 ft<sup>2</sup> with the ground floor covering 5650 ft<sup>2</sup>. Z-41 is currently evacuated and in a mothball state. (See Figure 1-16).

Launch Area Number 1 - This is the site of a 50K rail launcher used to support large suborbital sounding rocket missions (see Figure 1-10). The launch site is currently active.

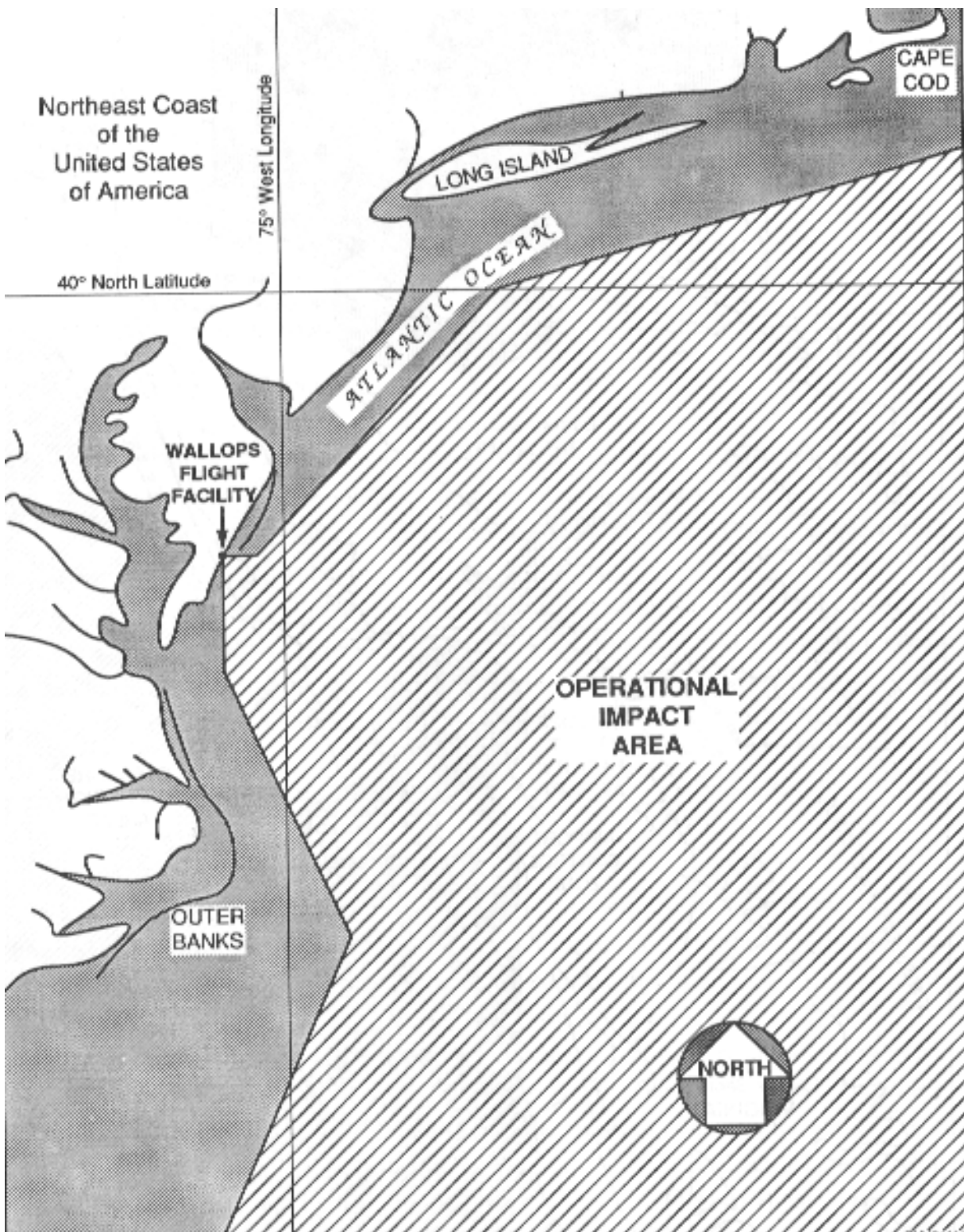


Figure 1 - 8: WFF Range (Impact Areas)

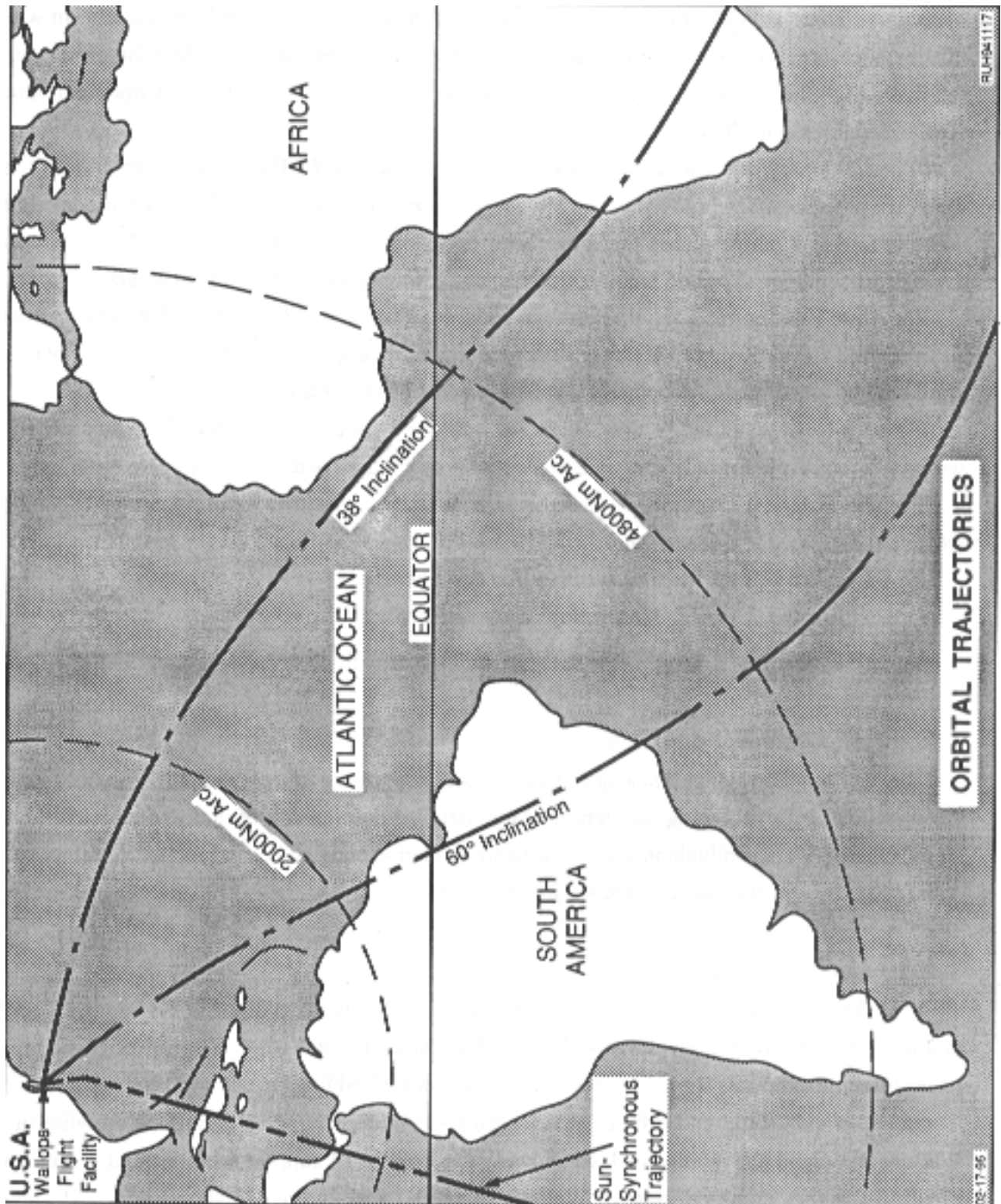
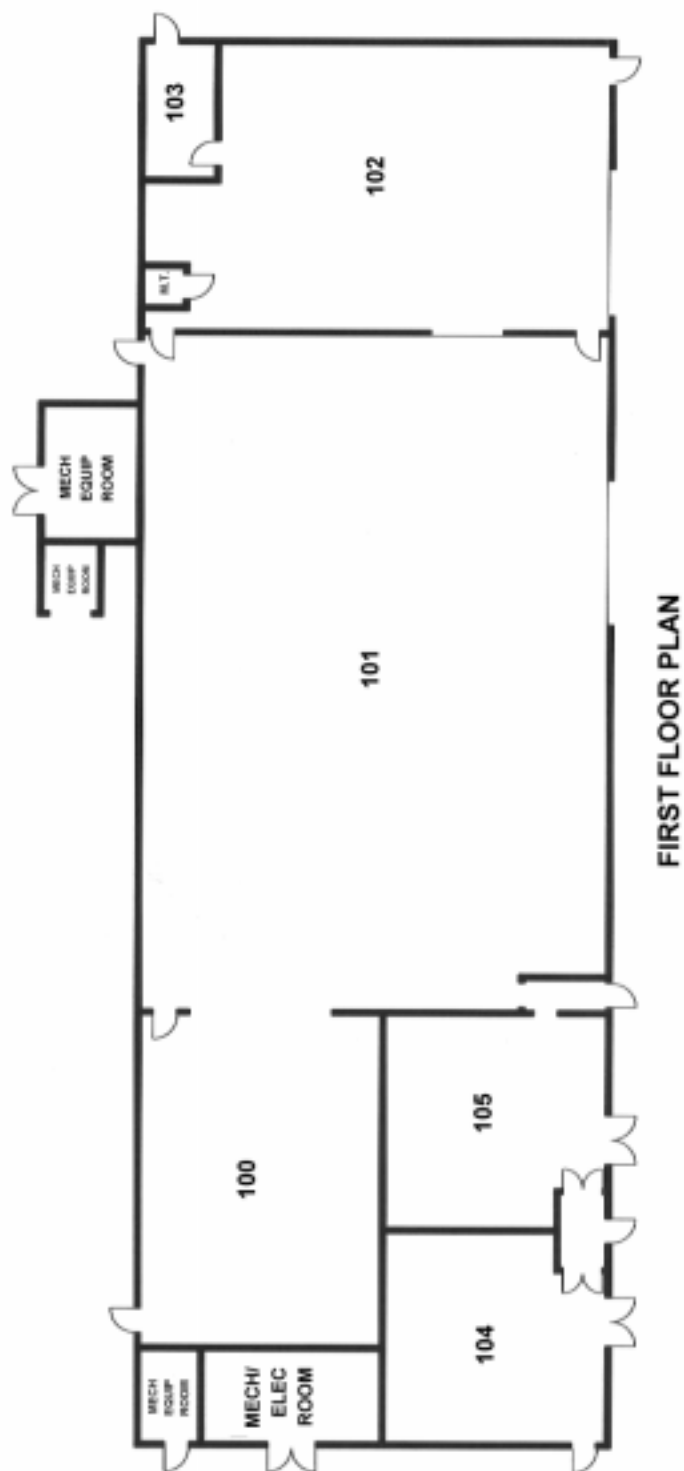


Figure 1 - 9: WFF Range (Range of Inclinations)



Figure 1 - 10: Wallops Flight Facility Complexes and Facilities



BUILDING NO. M-16

**Figure 1 - 11: M-16, Payload Processing Facility**

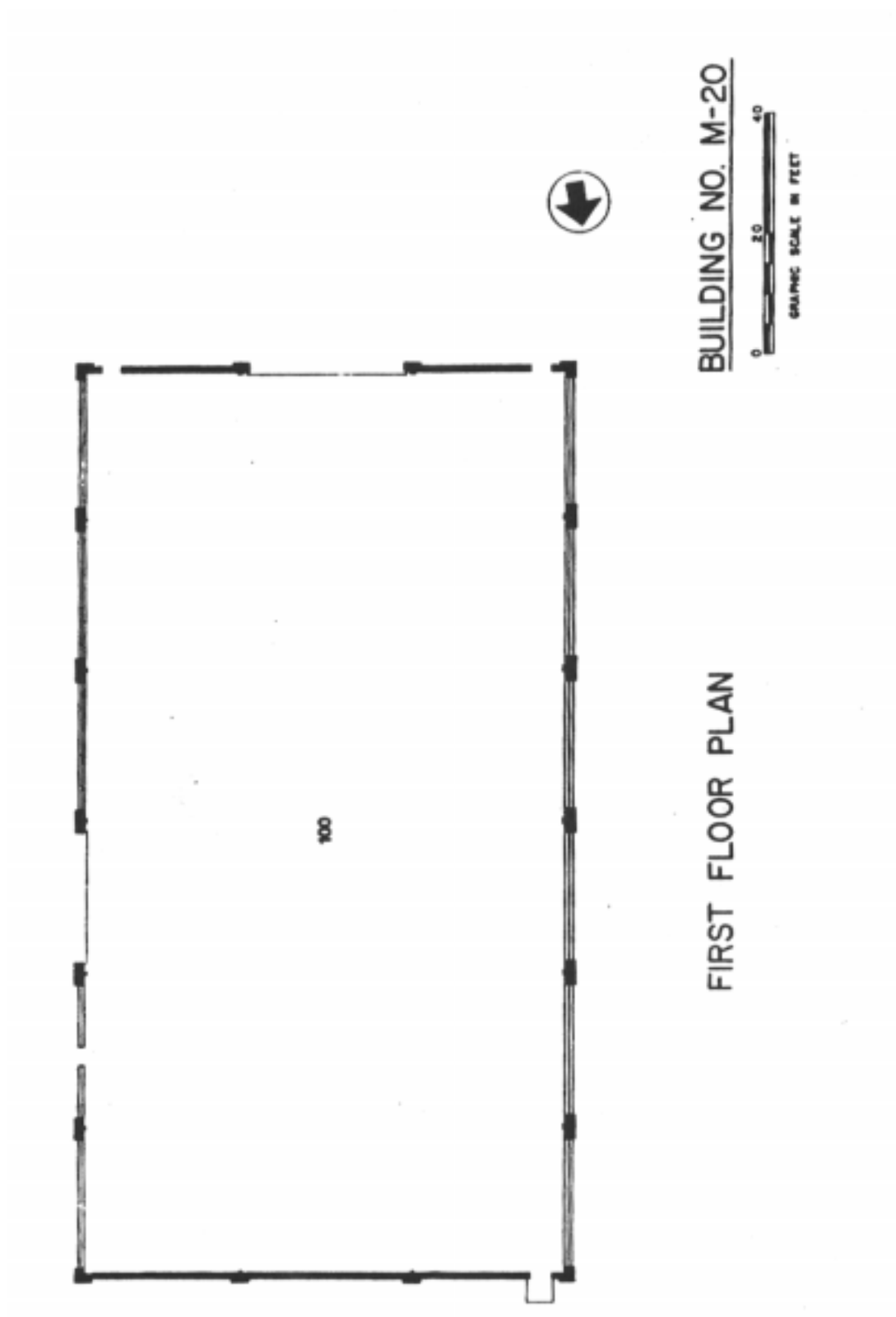
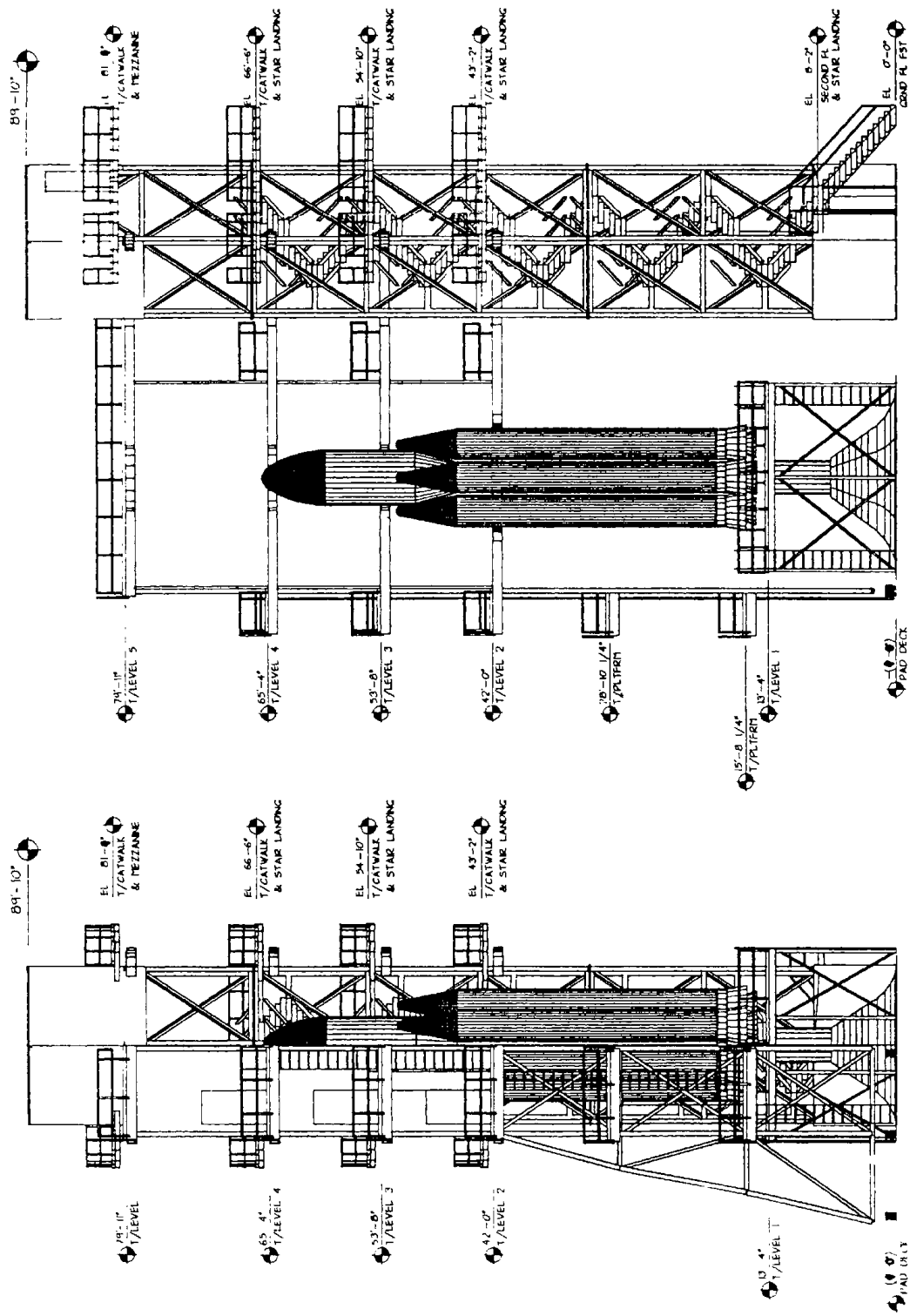


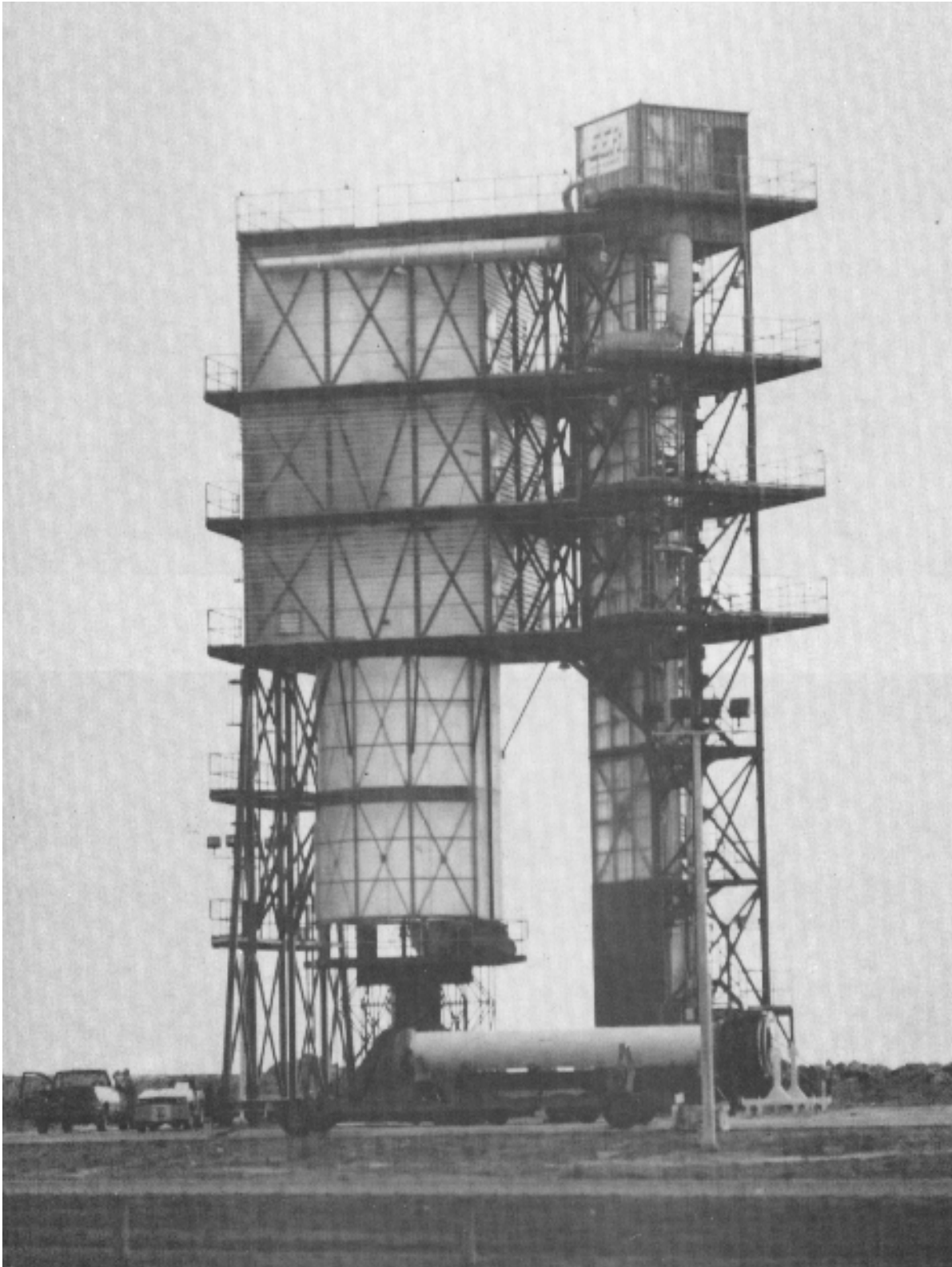
Figure 1 - 12: Pegasus Launch Processing, M-20



NORTH ELEVATION

WEST ELEVATION

Figure 1 - 13: Pad 0A Elevations



**Figure 1 - 14: Multilevel Commercial ELV Launch Complex Pad 0A**

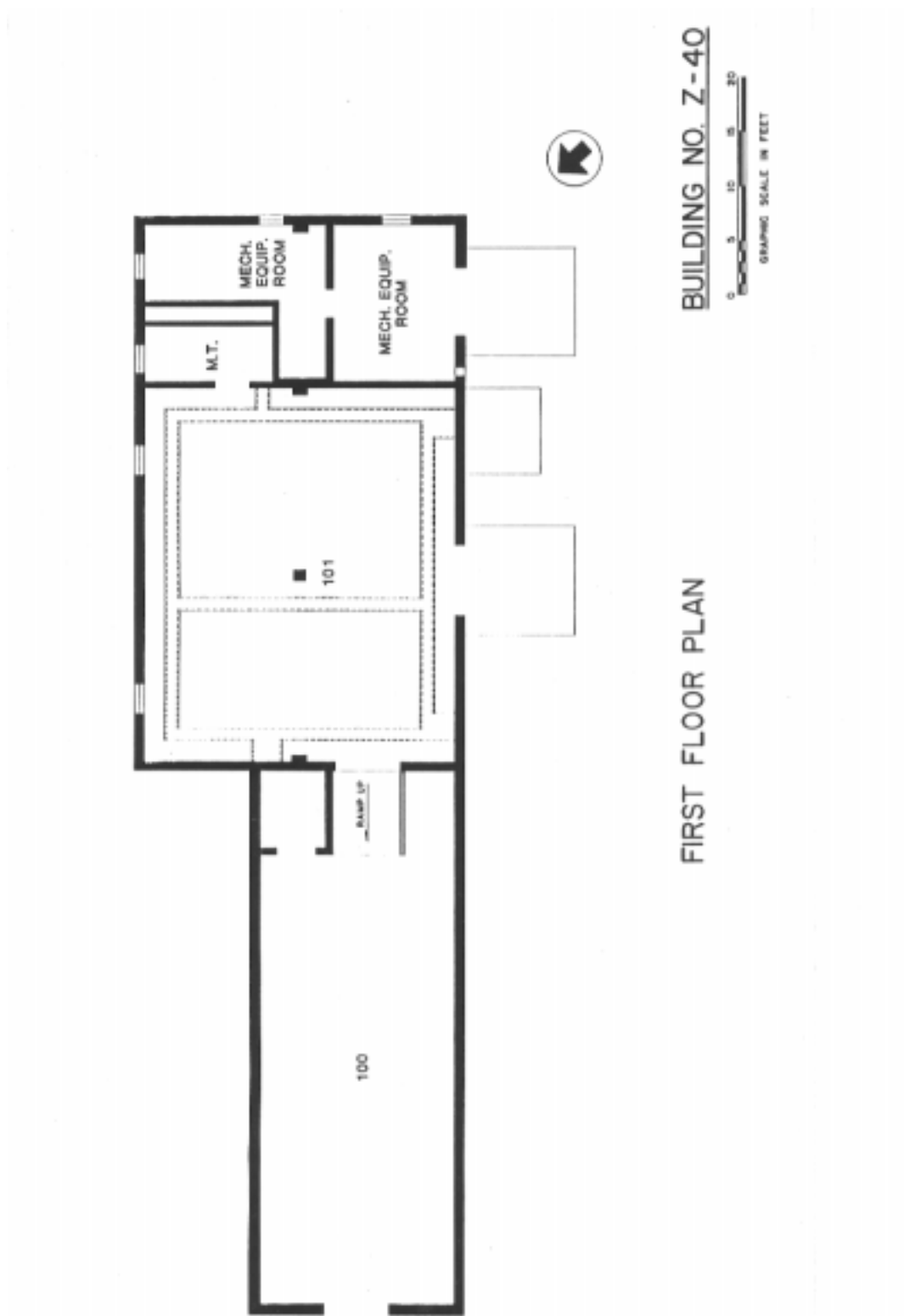


Figure 1 - 15: Building Z-40, Blockhouse Zero



THIRD FLOOR PLAN

BUILDING NO. Z-41  
GRAPHIC SCALE IN FEET



SECOND FLOOR PLAN

BUILDING NO. Z-41  
GRAPHIC SCALE IN FEET



FIRST FLOOR PLAN

BUILDING NO. Z-41  
GRAPHIC SCALE IN FEET

Figure 1 - 16: Building Z-41, Vehicle Assembly

Launch Area Number 2 and Blockhouse Number 2 (Y-30) - Several types of launchers are located in this area (see Figure 1-10) to accommodate all small to medium size suborbital vehicles/missions. The types of vehicles carrying scientific experiments which are being, or have been, launched from this launch area include Nike-Tomahawk, Orion, Nike-Orion, and Black Brant sounding rockets, as well as the small Arcas and Super Loki meteorological rockets. The blockhouse (see Figure 1-17) has two bays/mechanical equipment rooms and 12 office/equipment rooms of varying sizes encompassing a total of 2,725 ft<sup>2</sup>. Assembly Building Y-15 (Figure 1-18) supports this launch site as well. It has eight bays/equipment rooms and two office/equipment rooms encompassing 8240 ft<sup>2</sup>.

Payload Facility (X-15) - X-15 is a two story facility located just south of the intersection of the coast road and the causeway from the mainland and just north of the Launch Area # 2 (see Figure 1-10). On the ground floor it has a large open area (single bay) covering 2,370 ft<sup>2</sup> that is used for non-hazardous payload processing. In addition it has several conference rooms, numerous offices, and lab space. The facility is used for both payload assembly and damage control (see Figure 1-19). Damage control (range emergency forces - fire and security) are located in the Southwest end of the building.

Launch Area Number 3 (Pads 3A and 3B) - Pad 3 is the pad from which the Scout vehicle has previously been launched (see Figure 1-10). It is located approximately one mile from the intercoastal waterway and two miles from the "public domain". Both pads employ a horizontal type launcher that allows the vehicle to be prepared and held in the horizontal position until a short time before launch. The mothballed Scout Launcher is located on Pad 3A. On Pad 3B is an environmentally covered 20K launcher for sub-orbital launches (See Figure 1-20). Pad 3B is used for some of the larger sounding rockets and special purpose missions, such as the Aries vehicle.

Checkout & Assembly Shop (W-65) - W-65 is located just west of Launch Area 3. It is a six bay building (See Figure 1-21) covering 13255 ft<sup>2</sup> and is designed for vehicle checkout and assembly of launch vehicles. Previous uses have been for the Scout vehicle and its payload. W-65 has an internal class 10,000 clean room for payload assembly and several smaller rooms, one for hazardous testing and the others for non-destructive testing.

Blockhouse Number 3 (W-20) - This concrete, dome-shaped building north of Launch Area No. 3 is the blockhouse from which operations on Launch Areas 0A, 0B, 1, 3, 4, and 5 are controlled (See Figures 1-10 and 1-22). The walls of this building are eight feet thick, reinforced concrete. It was built to withstand a direct hit by the Scout vehicle. It has multiple bays from which concurrent operations can be supported. For example, a Vandal, a Conestoga, and a sounding rocket in varying phases of operation could be supported at the same

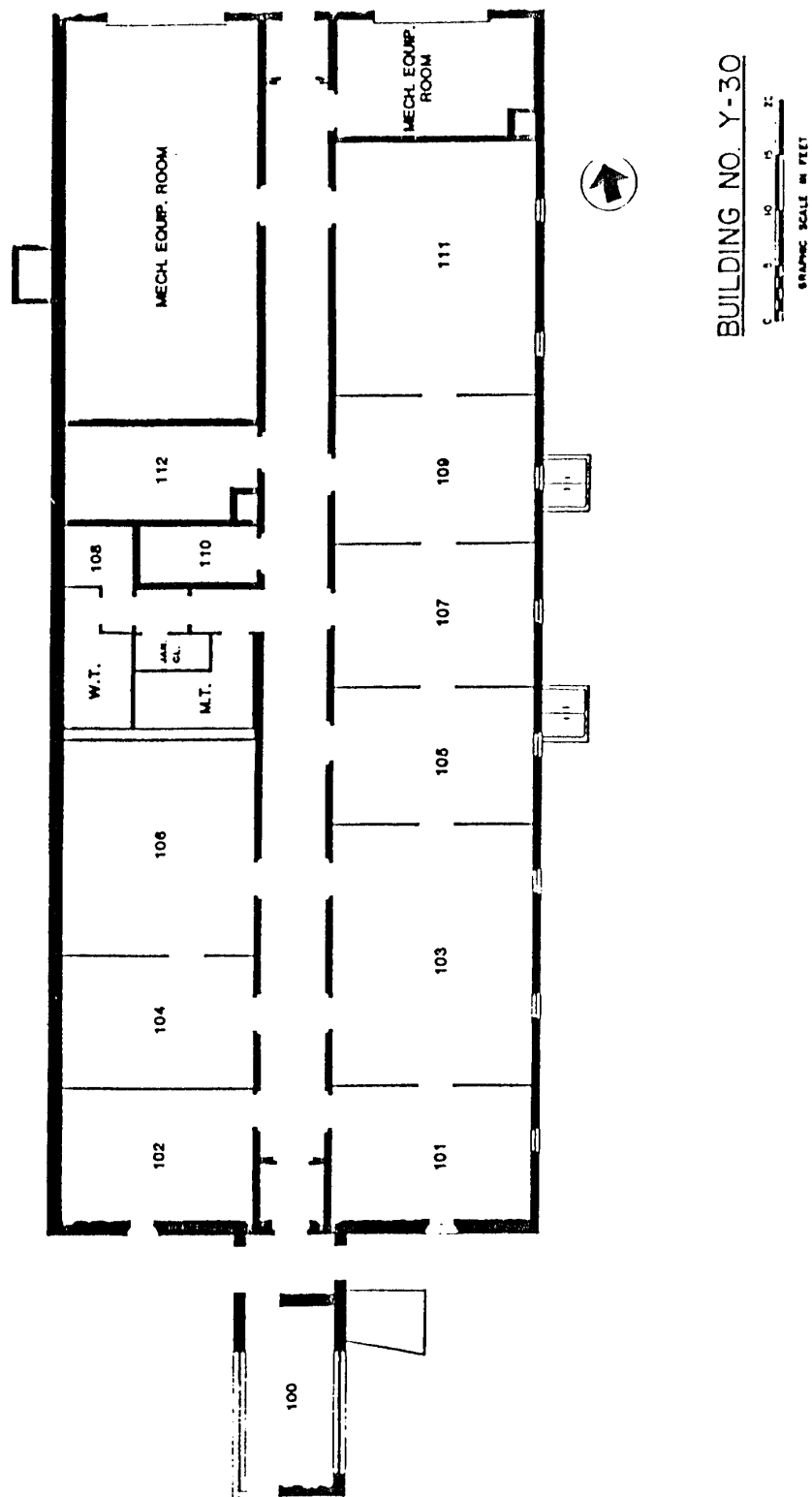


Figure 1 - 17: Building Y-30, Blockhouse Two

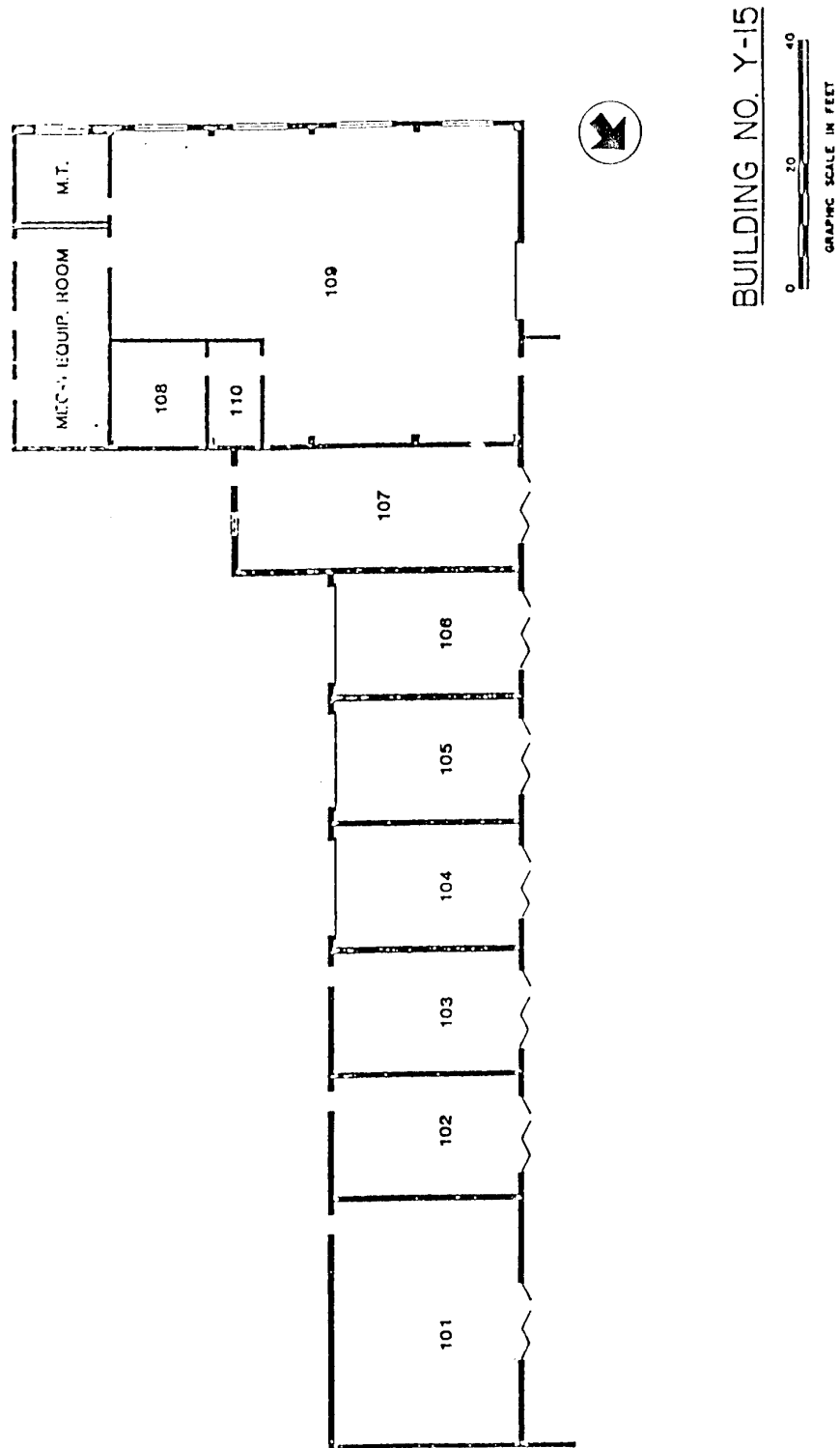
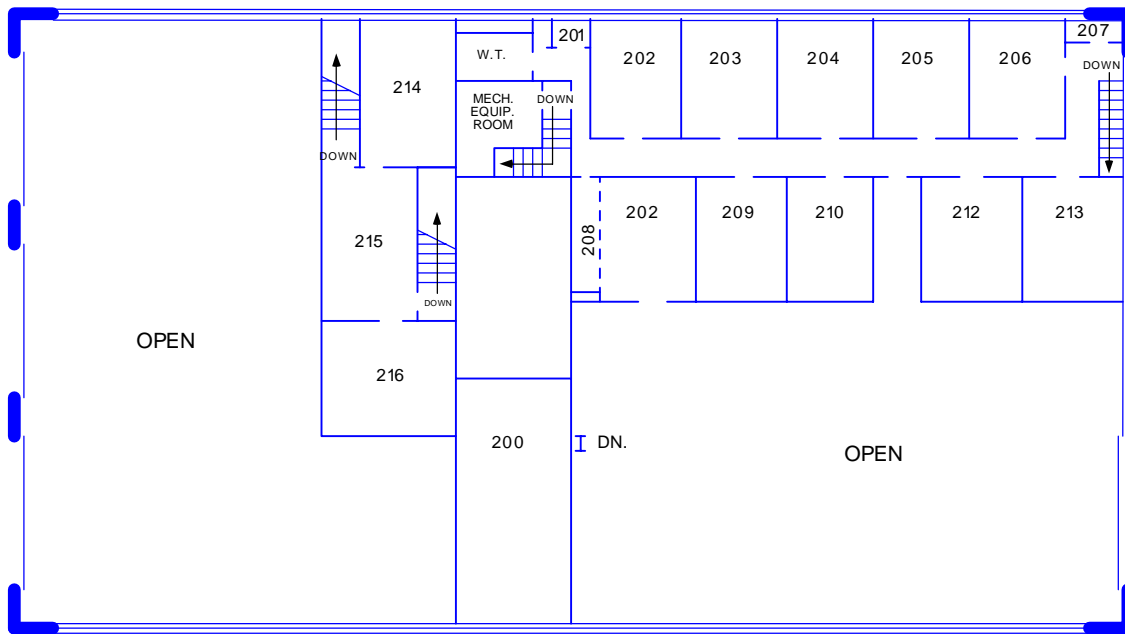
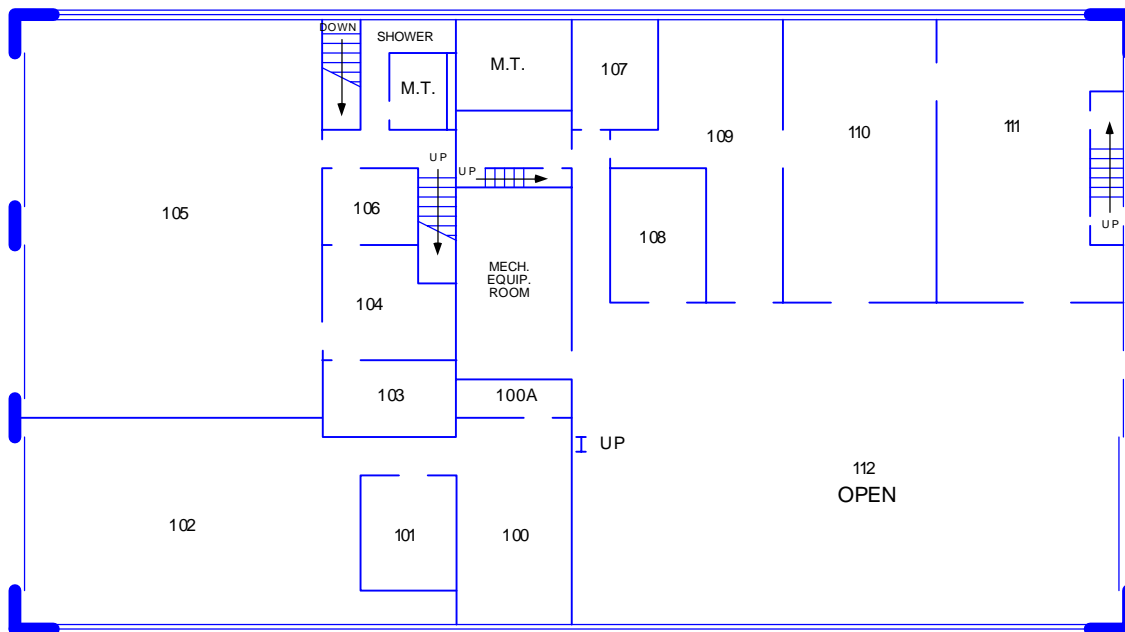


Figure 1 - 18: Building Y-15, Vehicle Assembly



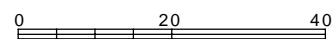
**SECOND FLOOR PLAN**



**FIRST FLOOR PLAN**



**BUILDING NO. X-15**



**Figure 1 - 19: Building X-15, Payload Processing**

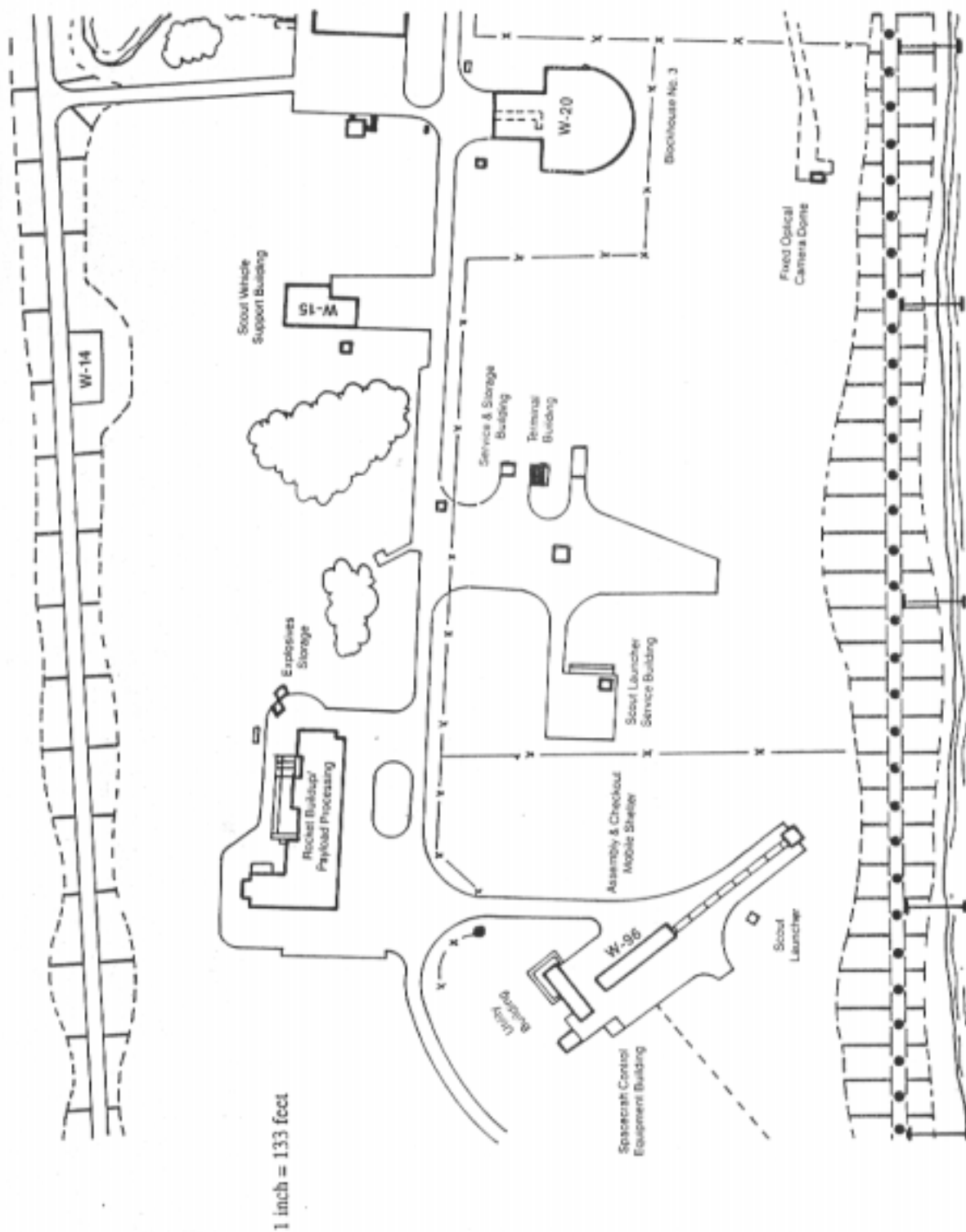


Figure 1 - 20: Launch Area 3, Scout

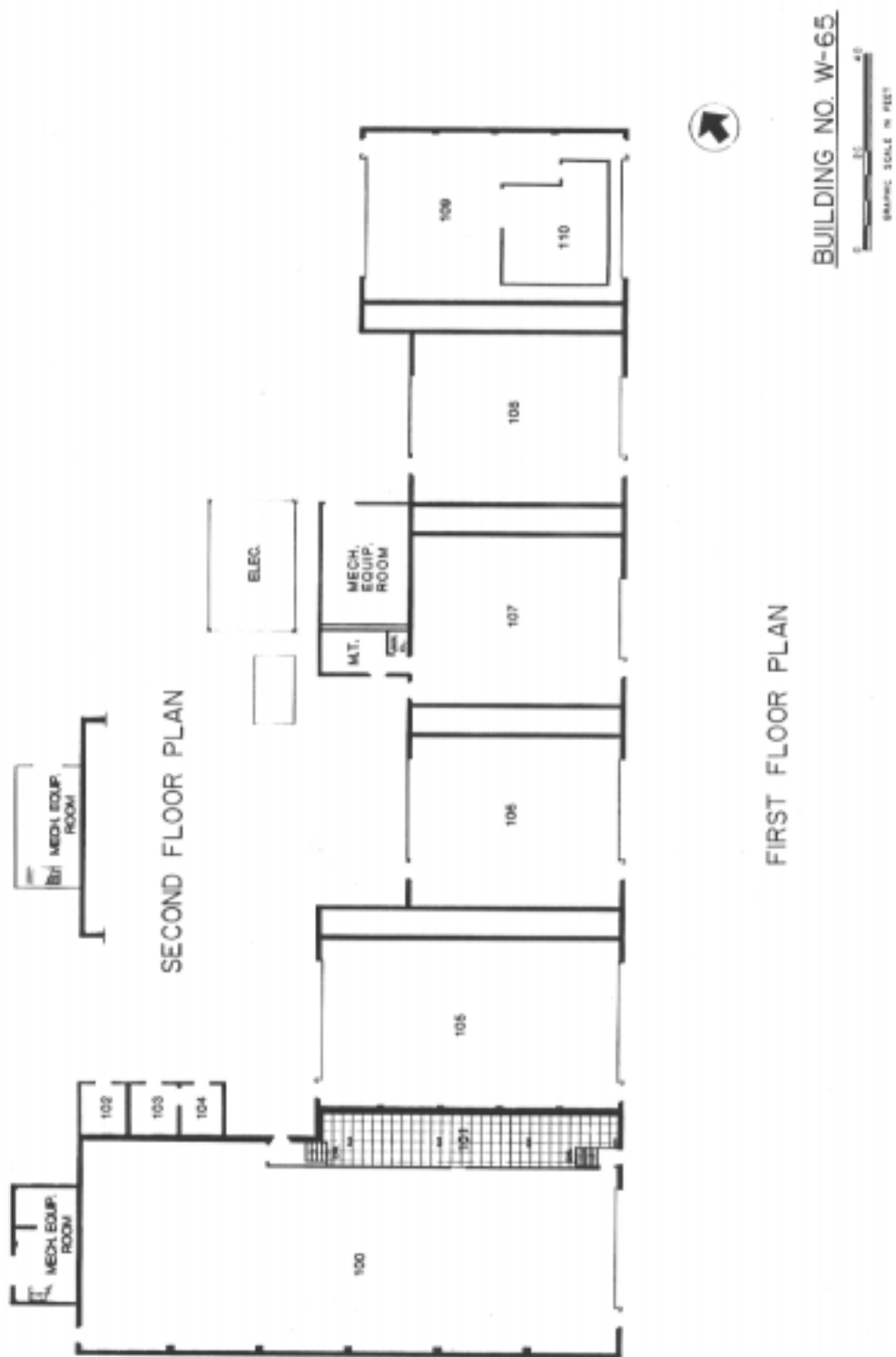


Figure 1 - 21: Building W-65, Vehicle Assembly

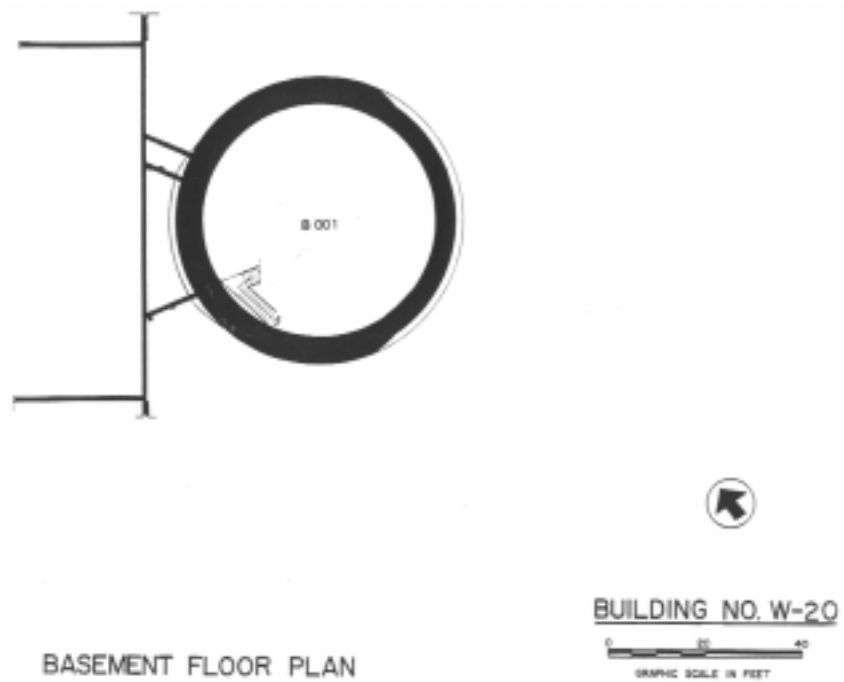
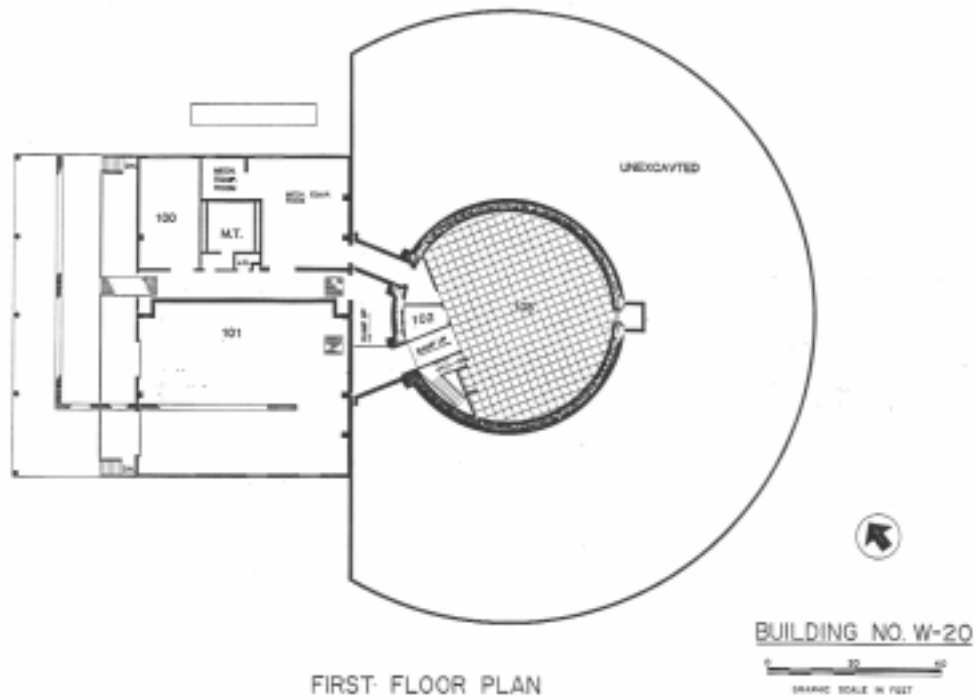


Figure 1 - 22: Building W-20, Blockhouse Three

time. Tables with PC-based workstations are set up to provide user support. Data from pad cameras and other external data sources are routed to monitors in each bay area.

**Launch Area Number 4** - This area is currently inactive but was previously used for sounding rocket launches (See Figure 1-10).

**Launch Area Number 5** - This is the launch site for the Vandal missile (See Figure 1-10). Vandal is a two-stage supersonic missile about 22 feet long and 30 inches in diameter. It is used as a target missile for off-shore Navy surface warship defense system tests. The dual launcher on this site will allow two vehicles to be configured, counted, and launched in a near salvo mode.

**Dynamic Balancing Facility** - The Dynamic Balancing Facility is used to balance rockets and large spacecraft. The facility consists of three buildings: V-45, V-50, and V-55 (See Figure 1-23). Buildings V-45 and V-55 contain dynamic spin balance bays, while Building V-50 contains the spin balance control rooms.

**Rocket Motor Ready Storage, V-80** - This is located on the north end of the island (See Figure 1-10). It is 2,750 ft north of the Spin Balance facility, V-45, 2,500 ft from the coast, 450 ft from the coast road, and approximately 4,000 ft from the north end of the island. The entire 5,845 ft<sup>2</sup> facility is rated for, and used as, a hazardous storage facility (See Figure 1-24 and Figure 1-25). This facility is sited for 1.3 propellant.

**Rocket Motor Storage, V-67** - This is a newly-constructed rocket motor storage facility at the north end of the island NE of V-80 and 4,000 feet from the Spin Balance facility. (See Figures 1-25 and 1-26). This facility is sited for 1.1 propellant.

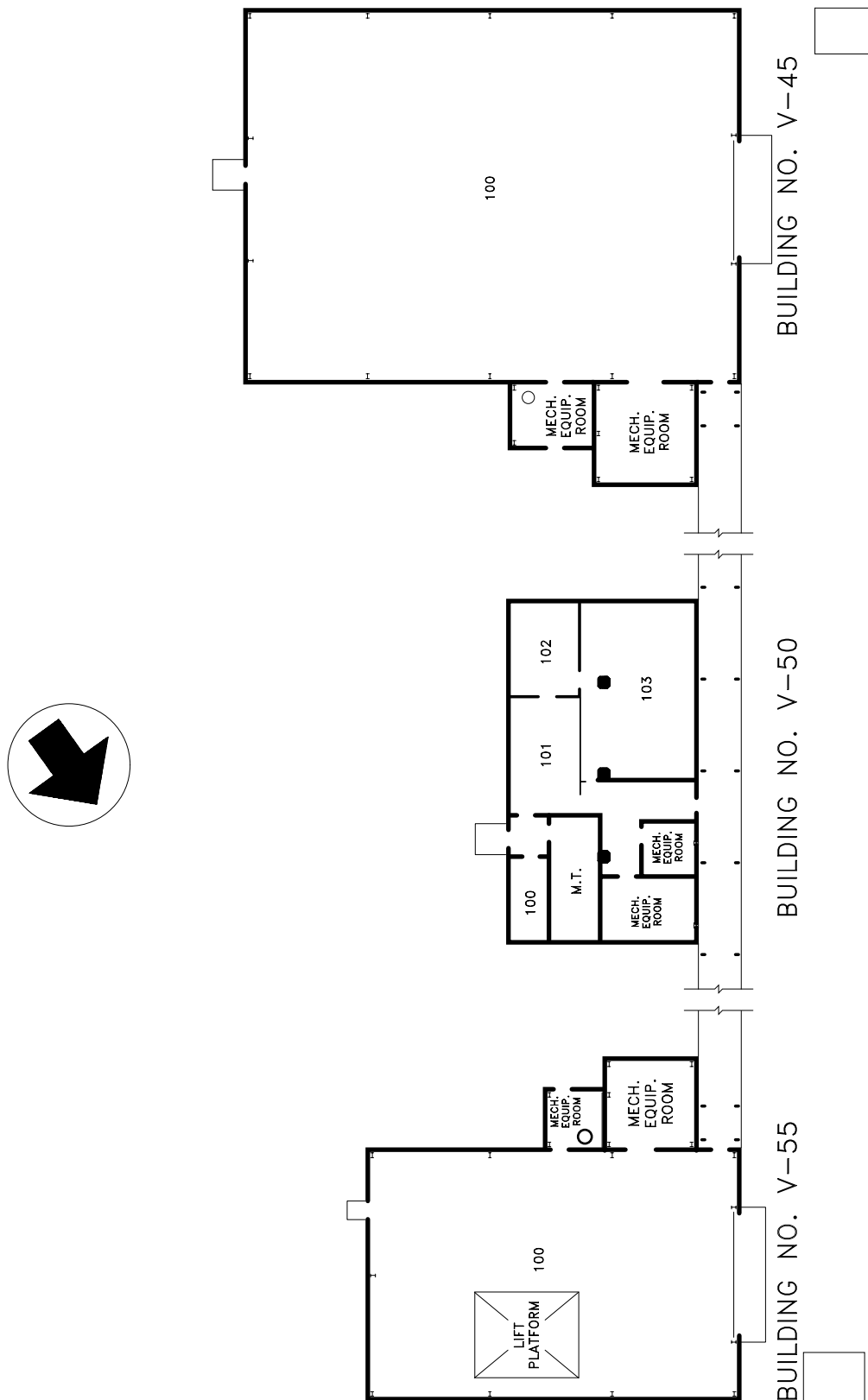
**General Support Facilities/Areas** - In addition to the above, there are multiple checkout, storage and assembly areas, a spin balance facility, and other support facilities and shops present on the island.

## **1.2.2 Local and Off-Range Instrumentation**

This section contains detailed descriptions to include performance characteristics, coverage limits, and operating frequencies of the instrumentation systems generally used in the support of WFF launch operations.

### **1.2.2.1 Radar Systems**

Radar systems track launch vehicles, sounding rockets, balloons, space vehicles, satellites, and aircraft to provide accurate velocity and position data. The range of support provided by radar systems at Wallops can vary from tracking local aircraft



**Figure 1 - 23: Building V-45, 50, and 55 Dynamic Balancing Facility**

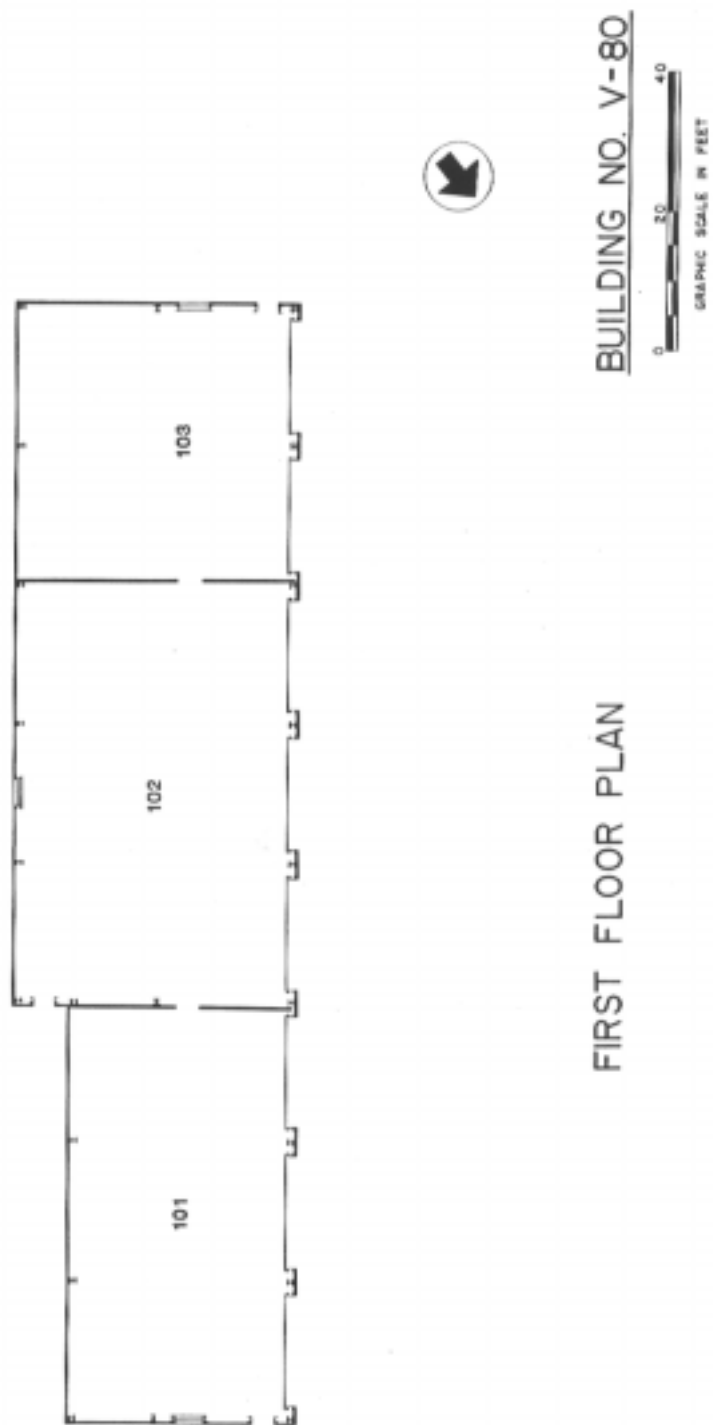


Figure 1 - 24: Building V-80, Rocket Motor Ready Storage

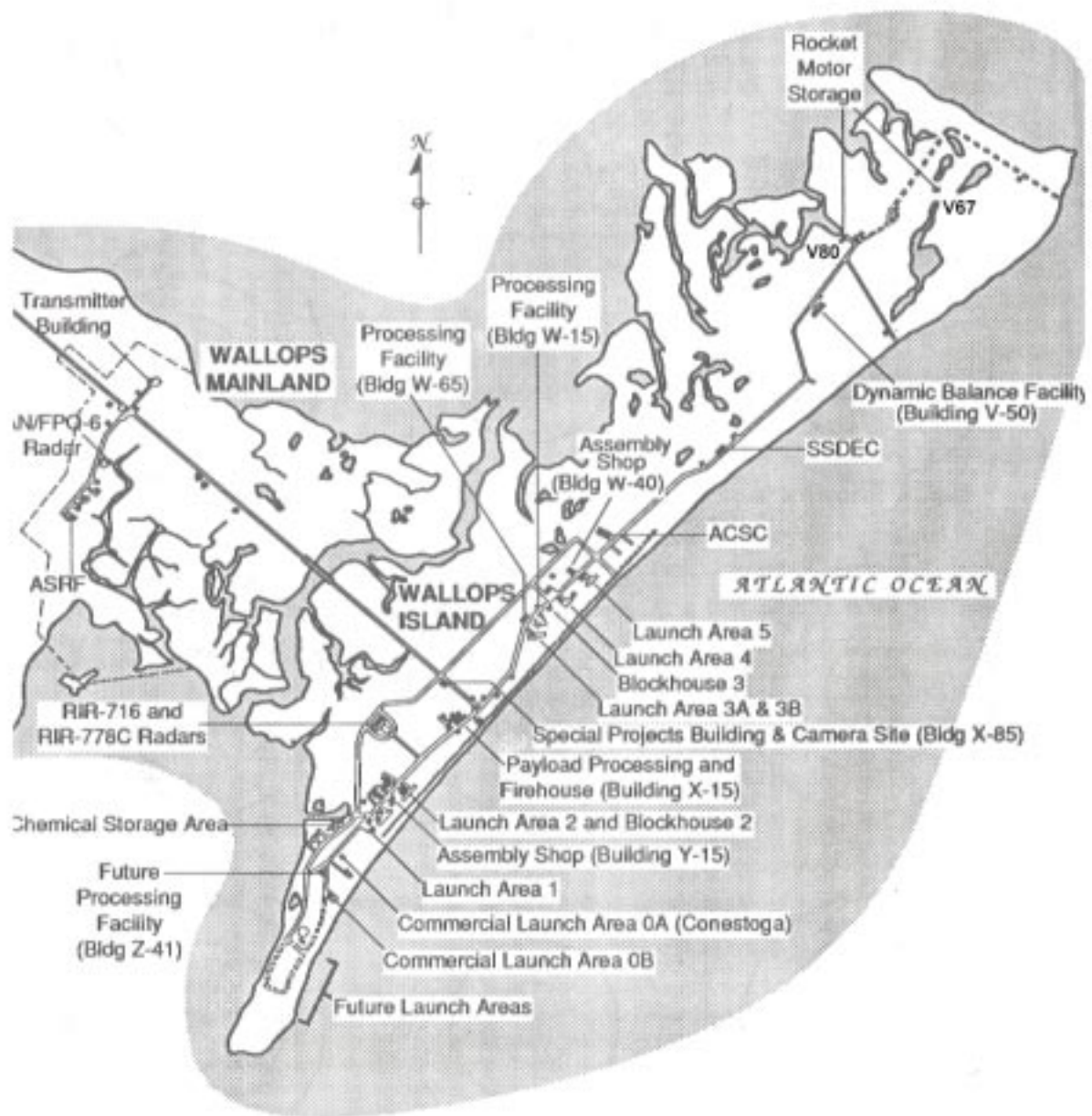


Figure 1 - 25: WFF Mainland and Island Test Range Launch Facilities

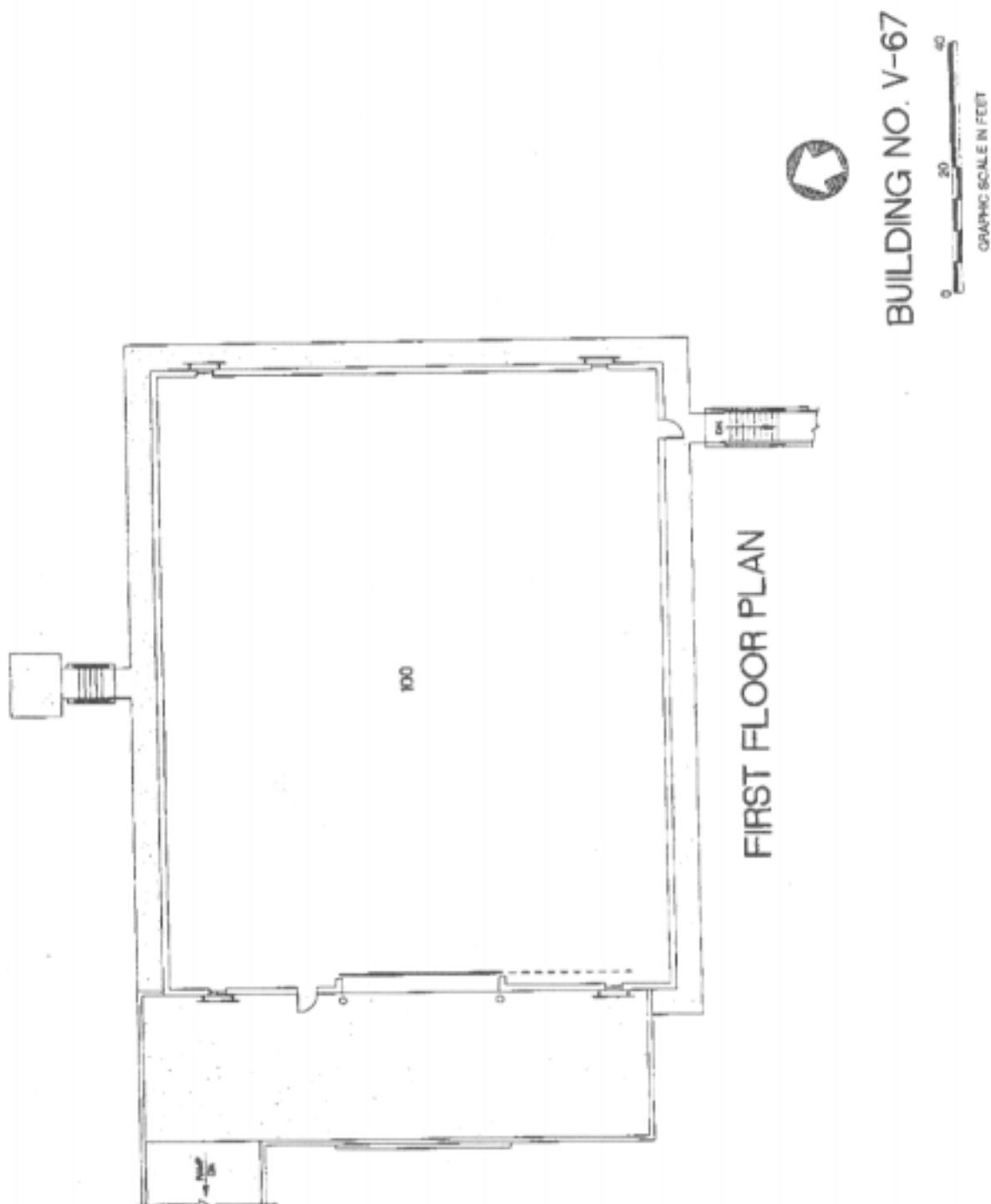


Figure 1 - 26: Building V-67, Explosive Storage Magazine

in the vicinity of Wallops airport to tracking distant objects in space. Radar capabilities can be enhanced by laser tracking systems and sophisticated data processing systems to improve the precision and to record, analyze, and process radar data. Radar performance characteristics, maximum range, and operating frequencies are shown in Tables 1-1, 1-2, and 1-3. The information provided in the following sections is representative of the support capability provided by WFF for commercial launch operations. Radar system resources are subject to change due to mission requirements, revisions and modifications and new technology.

#### Airborne Radar

Some Wallops Flight Facility aircraft are radar-equipped to support experiments and operations by providing range surveillance.

#### Fixed Radar

Island radars are located just south of the causeway. A C-band RIR-716 radar is located at building Y-55, while the X-band Mariner's Pathfinder radar is at building X-5 (see Figures 1-25 and 1-27).

Mainland radars are located on the mainland just south of the Wallops Island causeway. These radars consist of an FPQ-6, a UHF and an ASRF S-band SPANDAR. In addition, there is a C-band RIR-716 radar, which can be used to support launch operations, located at building A-41 (see Figure 1-28).

Additional radar systems from the Eastern Range resources are not normally used in support of WFF launches; however, they can be scheduled as necessary to support mission and safety requirements.

#### Mobile Radar

WFF operations can also be supported by mobile radars (identified in Table 1-2). A Mobile System (mobile RIR-778C) may be deployed to the Coquina site near Cape Hatteras, North Carolina, Bermuda or elsewhere worldwide.

#### Transportable Radar

A transportable RIR-778C is located at Poker Flat Research Range, Alaska (See Table 1-3 for specifications).

### **1.2.2.2 Photo Optical Systems**

Still, video, and motion picture photography are available to support WFF activities and projects. Remotely-controlled television cameras monitor range operations and provide safety-related information. A processing/printing laboratory and limited video editing and reproduction facilities/capabilities are also available. See Table 1-4 and Figure 1-29 for optical system specifications and locations.

**Table 1 - 1 WFF Airborne and Fixed Radar System Statistics**

<b>WFF ID No.</b>	<b>Radar</b>	<b>Wave Length Band</b>	<b>Peak Power Output (Watts)</b>	<b>Pulse Rate Frequency (pps)</b>	<b>Beam-width (deg.)</b>	<b>Antenna Size (Meters)</b>	<b>Antenna Gain (dB)</b>	<b>Max-Range (KM)</b>	<b>1-m<sup>2</sup> Skin Track (KM)</b>	<b>Range Precision (Meters) (rms)</b>	<b>Angle Precision (mils-rms)</b>	<b>Slewing Rates (deg/sec) AZ EL</b>
UHF	ASRF	UHF	8M	320-960	2.9	18.29	36	n/a	1480	n/a	±2.0	8 8
4	ASRF (Spandar)	S	5M	1.603e+11	0.39	18.29	52.8	480K	2200	±5	±1.0	15 15
6	AN/MPS-19	S	325K	1.603e+12	3	2.44	33	925	100	±10 KMS	±1.0	60 60
n/a	AN-ASR-7	S	425K	713,1200 Others available	1.5(AZ) CSC <sup>2</sup> (EL)	5.33 x 2.74	34	110	75 (air-craft)	±1%	n/a	n/a n/a
5	AN/FPQ-6	C	3M	160,640 Others available	0.39	8.84	51	60K	1300	±3 rms	±0.05	28 28
3	RIR-716 (Island)	C	1M	160,640 Others available	1.23	3.66	43	60K	350	±3 rms	±0.1	45 28
18	RIR-716 Airport Radar	C	1M	1.606e+09	0.71	4.88	46	60K	435	±3.0	±0.1	45 25
18	Airport Laser	Infra-red	125	40	0.11	0.18	n/a	40	n/a	±0.5	±0.1	n/a n/a
n/a	Mariner's #2 Path finder	X	20K (Min)	9.002e+10	0.9@ 3 dB(H)	3.67 x 0.15	32	125	n/a	n/a	n/a	n/a n/a
n/a	AN/APS-80B (V)	9.2-9.6	200K	200	2.4 (H) 3.6 (V)	1.18 x 0.81	35	155	n/a	n/a	n/a	n/a
n/a	AN-MPS-128E	9.3	100K	2.674e+13	2.4 (H) 9.0 (V)	1.06 x 0.305	31	125	n/a	1% max. range	n/a	n/a

**Table 1 - 2 WFF Mobile Radar System Statistics**

<b>WFF ID No.</b>	<b>Radar</b>	<b>Wave Length Band</b>	<b>Peak Power Output (Watts)</b>	<b>Pulse Rate Frequency (pps)</b>	<b>Beam-width (deg.)</b>	<b>Antenna Size (Meters)</b>	<b>Antenna Gain (dB)</b>	<b>Max-Range (KM)</b>	<b>1-m<sup>2</sup> Skin Track (KM)</b>	<b>Range Precision (Meters) (rms)</b>	<b>Angle Precision (mils- rms)</b>	<b>Slewing Rates (deg/sec) AZ EL</b>
2	RIR-778C (mobile)	C	1M (Min)	160-320-640	3	2.38	38	3745	220	0.87204	0.2441	40 40
8	RIR-778C (mobile)	C	1M (Min)	160-320-640	3	2.38	38	3745	220	0.87204	0.2441	40 40
9	RIR-778C (mobile)	C	1M (Min)	160-320-640	3	2.38	38	3745	220	0.87204	0.2441	40 40

**Table 1 - 3 WFF Transportable Radar System**

<b>WFF ID No.</b>	<b>Radar</b>	<b>Frequency (GHz)</b>	<b>Peak Power Output (Watts)</b>	<b>Pulse Rate Frequency (pps)</b>	<b>Beam-width (deg.)</b>	<b>Antenna Size (Meters)</b>	<b>Antenna Gain (dB)</b>	<b>Max-Range (KM)</b>	<b>1-m<sup>2</sup> Skin Track (KM)</b>	<b>Range Precision (Meters) (rms)</b>	<b>Angle Precision (mils- rms)</b>	<b>Slewing Rates (deg/sec) AZ EL</b>
11	RIR-778C (transportable)	C	1M	160-320-640	3	3.66	43	60K	425	3.00	0.15	35 35

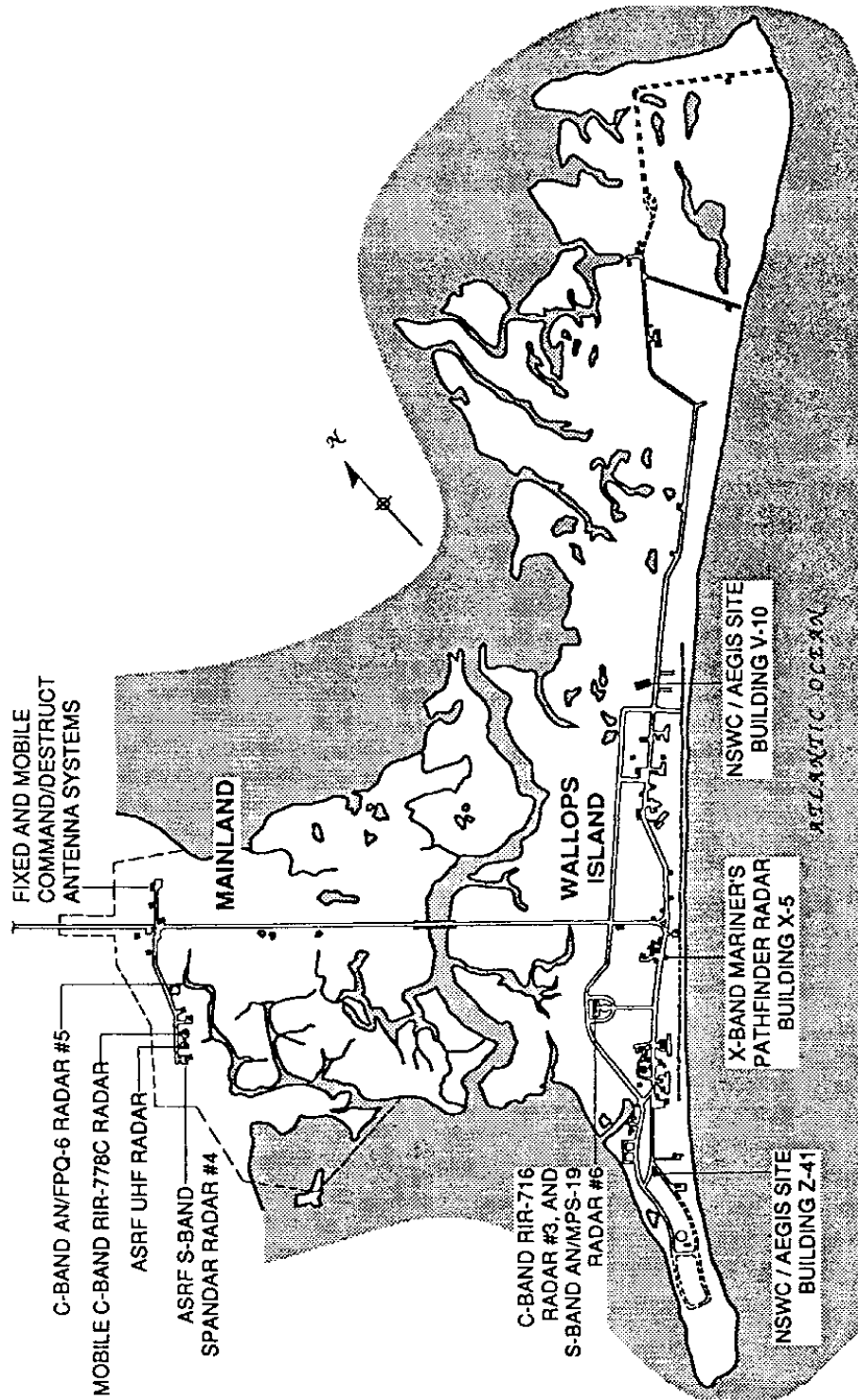


Figure 1 - 27: Wallops Island & Mainland Radar Sites, Mainland Command Sites

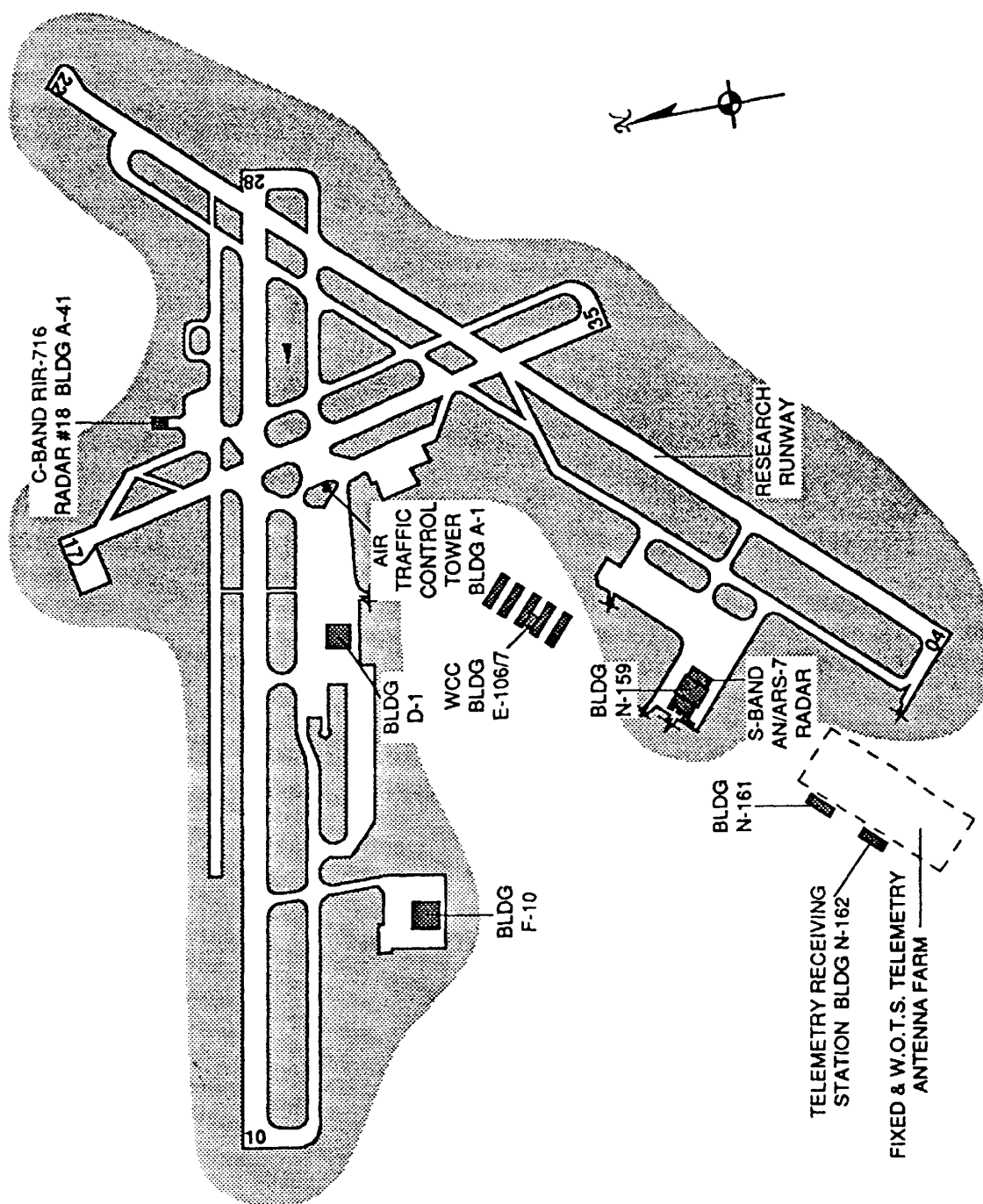


Figure 1 - 28: WFF Main Base Radar and Telemetry Sites

**Table 1 - 4: Photo Optical Systems**

ID No.	Station	System Type	Track Modes	Tracking Rates	Camera Type	Film Type	Lens Focal Length	Environmental Control
#1	Tracking	IFLOT Mk 1	EL/AZ Manual	22 deg/sec	MP Film	16-mm	40-inch 80-inch	12 foot Astrodome Shelter
#2	Tracking	SOT Mk 51	EL/AZ Manual	Manual	MP Film TV	16-mm Video	15-inch 12-inch	10 foot Astrodome Shelter
#4	Tracking	IFLOT Mk 3A	EL/AZ Manual	30 deg/sec	MP Film TV	16-mm Video	80-inch 40-inch	12 foot Astrodome Shelter
#5	Tracking	SOT Mk 51	EL/AZ Manual	Manual	MP Film TV	16-mm Video	10-20-inch ZOOM	10 foot shelter
#8	Tracking	IFLOT Mk 1	EL/AZ Manual	22 deg/sec	MP Film	16-mm	40-inch 40-inch	12 foot Astrodome Shelter
#9	Tracking	IFLOT Mk 3 (Mobile)	EL/AZ Manual	32 deg/sec	MP Film	16-mm	40-inch 80-inch	N/A
#11	Tracking	IFLOT Mk 1 (Mobile)	EL/AZ Manual	22 deg/sec	MP Film	16-mm	No Camera or Lens Assigned	N/A
#12	Tracking	IFLOT Mk 1 (Mobile)	EL/AZ Manual	22 deg/sec	MP Film	16-mm	6-to 80-inch	N/A
#15	Tracking	IFLOT Mk 3	EL/AZ Manual	32 deg/sec	MP Film TV	16-MM Video	80-Inch 80-Inch	12-foot Fixed Shelter
W-60	Fixed	Stationary Mount	Fixed	N/A	MP Film Sequence Film	16-mm 70-mm	12-mm to 12-inch 6- to 12-inch	10 foot Fixed Shelter
W-115	Fixed	Stationary Mount	Fixed	N/A	MP Film Sequence Film	16-mm 70-mm	12-mm to 12-inch 6-to 12-inch	10 foot Fixed Shelter
Y-110	Fixed	Stationary Mount	Fixed	N/A	MP Film Sequence Film	16-mm 70-mm	12-mm to 12-inch 6-to 12-inch	10 foot Fixed Shelter

IFLOT: Intermediate Focal Length Optical Tracker

SOT: Short Range Optical Tracker

MP: Motion Picture

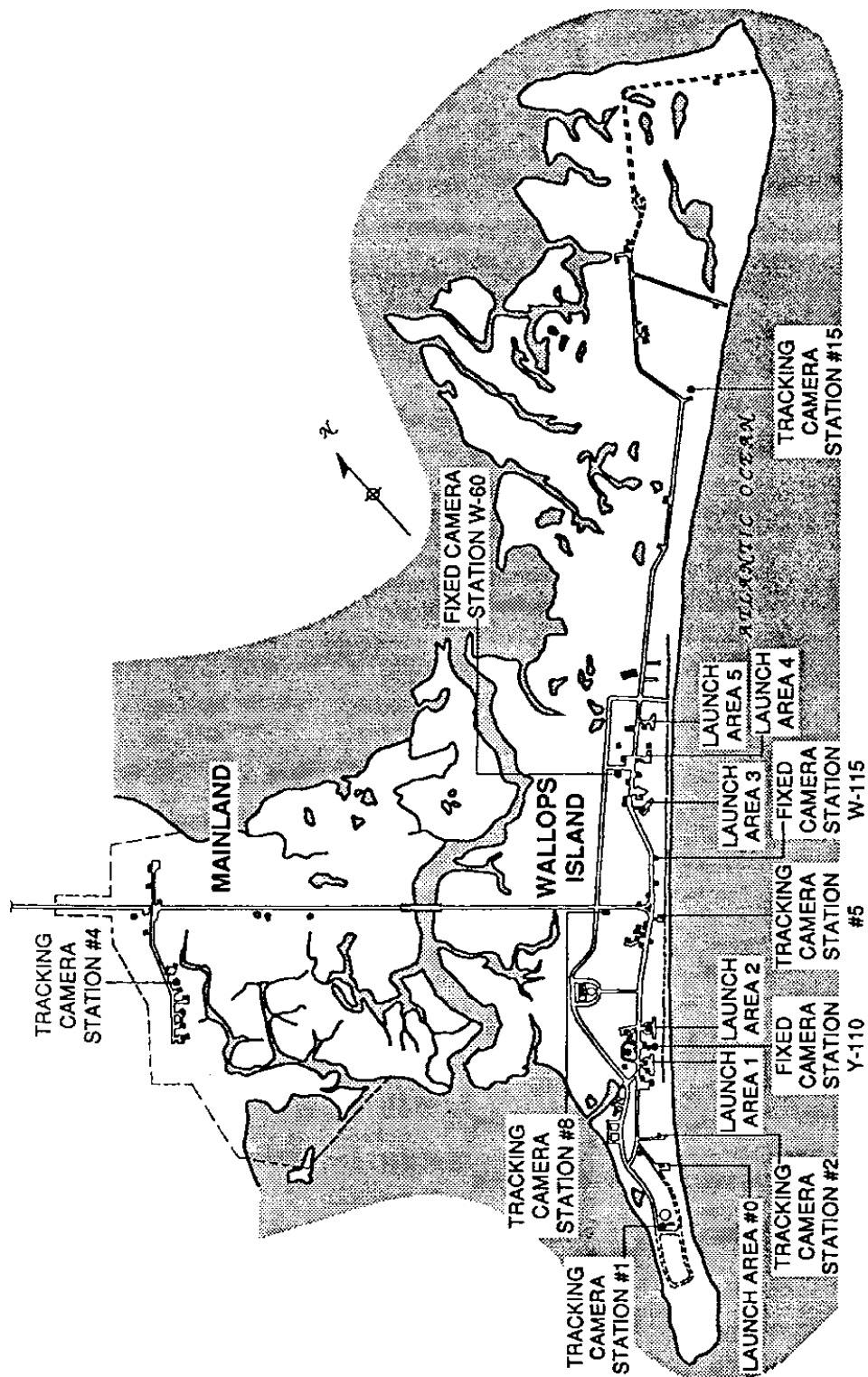


Figure 1 - 29: WFF Island and Mainland Optical Tracking Stations

## Tracking and Fixed Camera Stations

Tracking and fixed cameras, including both film and a long-range video tracking system, provide visual information from island locations primarily for support of rocket and balloon launches.

## Mobile Systems

Mobile tracking camera equipment can be transported to remote sites to provide required support.

## Aerial Platforms

Still, motion picture, and video cameras can be installed on several WFF aircraft

### 1.2.2.3 Telemetry Systems

WFF has fixed and transportable telemetry systems/facilities to be used in support of rocket launches and low earth orbit spacecraft. Where experiments employ multiple RF carriers, selection of a carrier for tracking purposes is a range user's option, since it does not impinge on the reception of telemetry data. The fixed-receiver system offers the range user a high degree of flexibility and redundancy. Each of two identical systems contains six receivers with plug-in RF heads to cover the appropriate frequency band. All systems can receive multiple links over a broad frequency spectrum. Telemetry system specifications are included in Tables 1-5 through 1-9. The information provided in the following sections is representative of the support capability provided by WFF for commercial launch operations. Telemetry system resources are subject to change due to mission requirements, revisions and modifications and new technology.

## Fixed Telemetry Systems

Multiple independently controlled telemetry antenna systems are located on the WFF Main Base near the approach to runway 04 (See Figure 1-28). These systems are controlled from the fixed range telemetry facilities and Wallops Orbital Tracking Station (WOTS), which are co-located in building N-162. An expanded view of the Mainland telemetry area is shown in Figure 1-30 and an aerial view appears as Figure 1-31. WOTS primarily supports low earth orbit spacecraft; however, its facilities are flexible enough to support range telemetry. In fact, WOTS shares resources with the range telemetry systems. Its capabilities include both metric tracking and command uplink. (See Tables 1-5, 1-7, and 1-9 for specifications).

**Table 1 - 5: Range Telemetry Systems (Fixed)**

**RECEIVING CHARACTERISTICS**

Antenna Type/Dia	Frequency Range	Polarizations	Noise Temp @ Degrees K	Receiver type	Gain	Tracking Modes	Pedestal Type
(1)Fixed Dish LGTAS 2.4M/8 ft	1435-1540 MHz 1650-1710 MHz 2200-2300 MHz	RHC/LHC	400 @ S-Band	Microdyne 1100-AR	L-Band: 28 dB 1680 Band: 29 dB S-Band: 32 dB	Autotrack Slave Manual Computer	EL/AZ
(2)Fixed Dish MGTAS 7.5M/24 ft	1400-2400 MHz	RHC/LHC	200 @1.4-2.1GHz 250 @2.2-2.3GHz	MFR S/A 410 DEI 74 Microdyne 1100-AR	39 dB @ 2250 MHz	Autotrack Slave Manual Programmed	EL/AZ

**TRANSMITTING CHARACTERISTICS**

Antenna Transmitter

Type/Dia	Freq. Range	Polarizations	Type	Power	Gain	Tracking Modes	Pedestal Type
(1)Fixed Dish LGTAS 2.4M/8 ft.	547 & 550 MHz	RHC	FM	30W	10 dB	Autotrack Slave Manual	EL/AZ

Notes:

1. The Low Gain Telemetry Antenna System (LGTAS) antennas reside atop Building N-162.
2. Medium Gain Telemetry Antenna System (MGTAS) is located in antenna field near building N-162. The MGTAS is also part of the WOTS system.
3. The WOTS 18M antenna system can be used for GSFC/WFF range support upon request. For data on 18M see Table 1-7.

**Table 1 - 6: Mobile/Transportable Telemetry Systems Summary**

Antenna Type/Dia.	Frequency Range	G/T (Minimum)	Tracking Modes	Pedestal Type	Trailer	Van	Remarks
Antenna #1 (M) 3M/10 ft 4 Section Parabolic	215-260 MHz 1435-1540 MHz 1650-1710 MHz 2200-2300 MHz	7.1 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	8.5M/28 ft Lowboy	Can be used with Van #1 (RV) and Van #2	Shipping container available; color, green.
Antenna #2 (M) 3M/10 ft Solid Parabolic	215-260 MHz 1435-1540 MHz 1650-1710 MHz 2200-2300 MHz	7.1 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	8.5M/28 ft Lowboy	Can be used with Van #1 (RV) and Van #2	Shipping container available; color, blue.
Antenna #3 (M) 2.4M/8 ft Solid Parabolic	1435-1540 MHz 2200-2300 MHz	5.18 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	5.5M/18 ft Lowboy	Can be used with Van #1 (RV) and Van #2	Antenna #3 is referred to as the "old 8-footer." Shipping container available; color, gray.
Antenna #4 (M) 2.4M/8 ft Solid Parabolic	1435-1540 MHz 2220-2300 MHz	5.18 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	5.5M/18 ft Lowboy	Can be used with Van #1 (RV) and Van #2	Antenna #4 is referred to as the "new 8-footer." Shipping container available; color, white.
Antenna #5 (M) 2.4M/8 ft Solid Parabolic Reflector	1435-2300 MHz (includes 1680)	5.18 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	n/a	n/a	Installed at Poker Flat Research Range
Antenna #6 (M) 2.4M/8 ft Solid Parabolic Reflector	1435-2300 MHz (includes 1680)	11.0 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	n/a	n/a	Installed at Poker Flat Research Range
Antenna #7 (M) 2.1M/6ft "Minitracker" 2 Section Parabolic	2200-2300 MHz	2.9 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	n/a; compact pedestal	n/a	Minitracker TM Systems can be shipped via nine boxes weighing 1000 lbs. (6.3675M/225 cu ft).
Antenna #8 (M) 2.1M/6ft "Minitracker" 2 Section Parabolic	2200-2300 MHz	2.9 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	n/a; compact pedestal	n/a	Minitracker TM Systems can be shipped via 9 boxes weighing 1000 lbs. (6.3675M/225 cu ft).
Antenna #9 (M) 6.1M/20ft 8 Section Mesh Parabolic	1435-1540 MHz 2200-2300 MHz	17.2 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	12.8M/42 Flatbed with an enclosed shelter	#4	Antenna #9 can be shipped in a C-141 aircraft.
Antenna #10 (M) 5.5M/18 ft 16 Section Mesh Parabolic	1435-1540 MHz 2200-2300 MHz	14.5 dB/K @ 2.25 GHz	Autotrack Slave Manual	EL/AZ	n/a	Self-equipped container	Antenna #10 is configured for shipborne transport.
Antenna #11 (T) 8M/26 ft Sectioned Solid Parabolic	2200-2400 MHz	xx dB/K 2.25 GHz @	Autotrack Slave Manual Program	EL/AZ	ISO Container 2 each 13M/43 ft	20-ft van	Can be shipped by C-141 or sea and truck.

**Table 1 - 7: Transportable Orbital Tracking Station (TOTS) Systems**

Receiving Characteristics

Antenna Type/Dia.	Frequency Range	Polarization	G/T (Minimum)	Receiver Type	Up/Down Con. Frequency	Tracking Modes	Pedestal Type
Transportable system 8M/26ft Parabolic	2200-2400 MHz Upper L-Band	RHC & LHC Diversity Combined Pre/Post Detection	150° K; 21 dB° K G/T	S/A 930; Microdyne 1400; Microdyne 1100; MFR, DEI 7400	Raw; 215-315 MHz 400-500 MHz	Auto; Manual; Slave; Computer	S/A 3315M; EL/AZ; 20°/Sec AZ/EL Velocity; 20°/sec AZ/EL Acceleration

Transmitting Characteristics

Antenna Type/Dia.	Frequency Range	Polarizations	Transmitter Type	Power	Tracking Modes	Pedestal Type
Helix 10 Turn	547, 550, 553 MHz	RHC	Various Types	200W RMS for 63 dBm	Auto; Manual; Slave Computer	S/A 3315M; EL/AZ: 20°/Sec AZ/EL Velocity; 20°/Sec AZ/EL Acceleration
Transportable System 8M/26 ft Parabolic	2025-2120 MHz	RHC or LHC	AYDIN Solid State	200W RMS for 93 dBm EIRP @ 2025 MHz	Auto; Manual; Slave Computer	S/A 3315M; EL/AZ: 20°/Sec AZ/EL Velocity; 20°/Sec AZ/EL Acceleration

- NOTES:
1. TOTS requires pre-positioned concrete pad for precision angular accuracy.
  2. Housed in a 40-foot expanding-side ISO container.
  3. Set-up time is estimated to be three days after arrival on site.

**Table 1 - 8: Transportable Van/TM System Summary**

VAN	SIZE	FUNCTION
Van #1 8M/26 ft RV	7.9m (26 ft)	<p>This is a self-propelled recreational research vehicle equipped to support various balloon programs. It is a modified GMT Transmode Van; gross wt of 4540 kg (10,000 lbs).</p> <p>Interfaces with Scientific Atlanta 2.4 m (8 ft) &amp; 3.3 m (10 ft) tracking antennas.</p>
Van #2 12M/40 ft expandable trailer	12.2 m (40 ft)	<p>Largest expandable instrumentation van (trailer) at Wallops that features automatically regulated air suspension sysstem for leveling and shock protection. Antenna controls for 2.4 m (8 ft) &amp; 3.3 m (10 ft) dishes are installed in this trailer.</p> <p>Two additional vans with similar characteristics are being procured.</p>
Van #3 12M/40 ft trailer	12.2 m (40 ft)	Standard 40 ft trailer used on various mobile campaigns with same capabilities as Van #2, less antenna controls.
Van #4 12.5M/42 ft trailer w/shelter	12.2 m (40 ft)	Specially equipped to provide full range control support at remote sites worldwide for the 6 m (20 ft) antenna system.
Self-equipped	3.3 m (10 ft)	Supports Mini-tracker system.
Pad-mounted	Various	Equipped to support pad mounted 8 m (26 ft) TM antenna.

**Table 1 - 9: Wallops Orbital Tracking Station (WOTS)**

Receiving Characteristics

Antenna Type/Dia.	Frequency Range	Polarizations	G/T (Minimum)	Receiver Type	Up/Down Con.Freq.	Tracking Modes	Pedestal Type
Parabolic Fixed dish 18M/60ft	1.4-2.4 GHz	LHC & RHC div	28.5 db/K@ 2.2-2.4 GHz 28 db/K @ 1.4-2.4 GHz	MFR	400-500 MHz P-Band	Manual, auto, STAR and STPS (future)	EL/AZ
Parabolic Fixed dish 9M/30ft	2.2-2.3 GHz	RHC & LHC div	23 db/K@ 22250 MHz	MFR	400-500 MHz	Auto, slave, TDPS, manual, and STPS (future)	X-Y
Parabolic Fixed dish S/A 7.3M/24 ft (STDN) 2 each	1.4-2.4 GHz	H/V or LHC & RHC div	16 db/K@ 2.2-2.4 GHz 13 db/K @ 1.4-2.4 GHz	MFR, S/A 410 DEI 74, 1100-AR	400-500 MHz P-Band	Auto, slave, manual, programmed	EL/AZ
Fixed Array 1 SATAN	136-138 MHz	Linear Diversity	-8 db/K@ 137 MHz	MFR	400-500 MHz	Manual, slave	X-Y
Fixed Array 2 SATAN	136-138 MHz	Linear Diversity	-8 db/K@ 137 MHz	MFR	400-500 MHz	Manual, slave	X-Y
Parabolic Fixed dish (dedicated) METEOSAT/ 7.3M/24ft	1690-1700 MHz	Linear Diversity	19.6 db/K@ 1690 MHz	1100-AR	400-500 MHz	Manual	EL/AZ Kingpost
Parabolic Fixed dish 7.3M/24ft UHF	464-469 MHz	RHC & LHC div	4.0 db/K@ 466 MHz	MFR	none	Manual, slave	X-Y

Transmitting Characteristics

Antenna Type/Dia.	Frequency Range	Polarizations	Transmitter Type	Power	EIRP	Tracking Modes	Pedestal Type
Fixed dish 9M/30ft	2025-2120 MHz	RHC/LHC	TWTA/exciter Solid State Amp	200 W/16 W	96 dBmi	Auto, slave TDPS, manual, and STPS (future)	X-Y
Fixed dish 6M/20ft Command	2025-2120 MHz	RHC/LHC	TWTA/exciter Solid State Amp	200 W/16 W	92 dBmi	Manual, slave	X-Y
Fixed Array SATAN	147-152 MHz	RHC/LHC Linear	Linear	10 KW	92 dBmi	Manual, slave	X-Y
Fixed Array SCAMP	147-152 MHz	RHC/LHC Linear	Linear	10 KW	87 dBmi	Manual, slave	X-Y

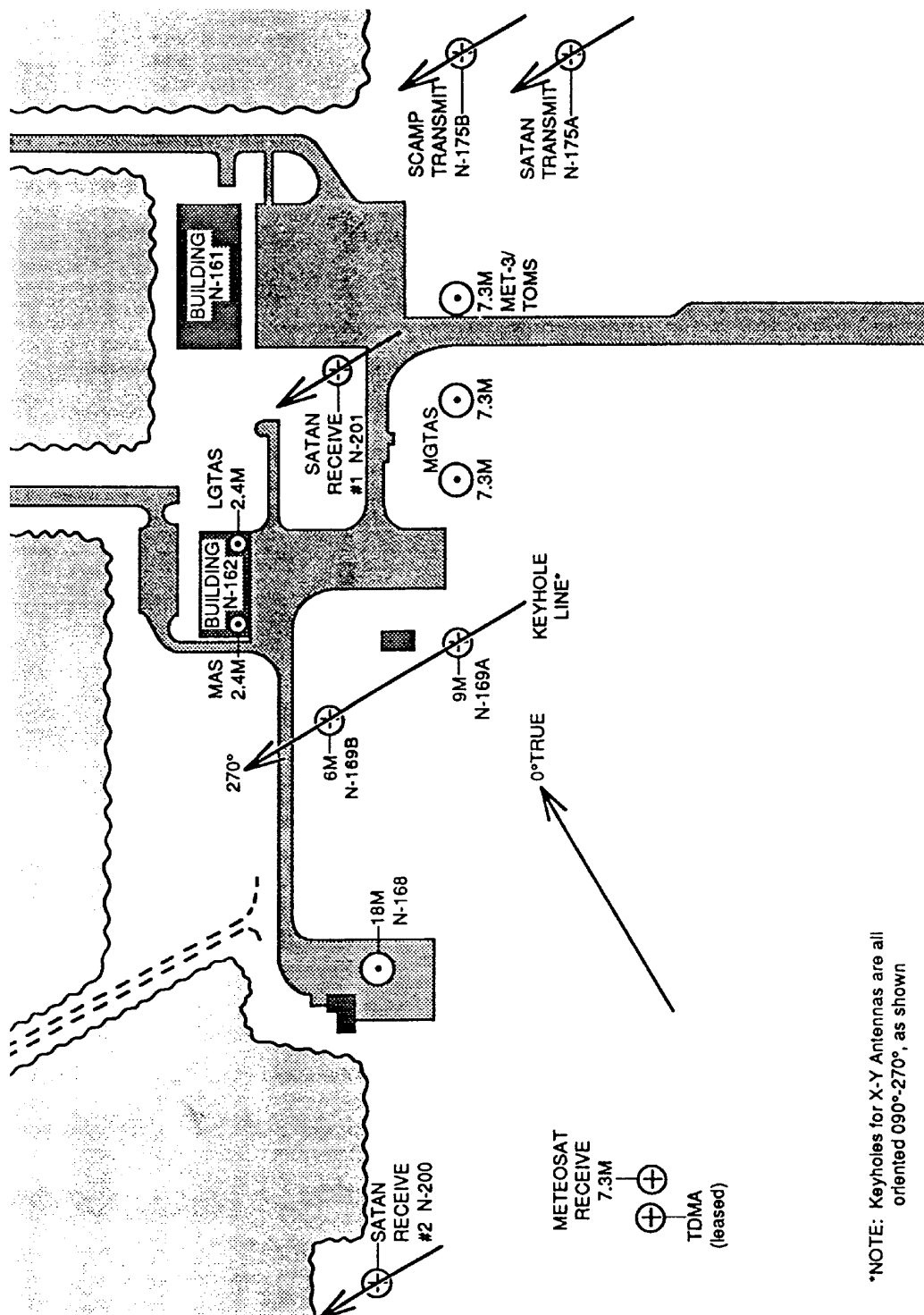
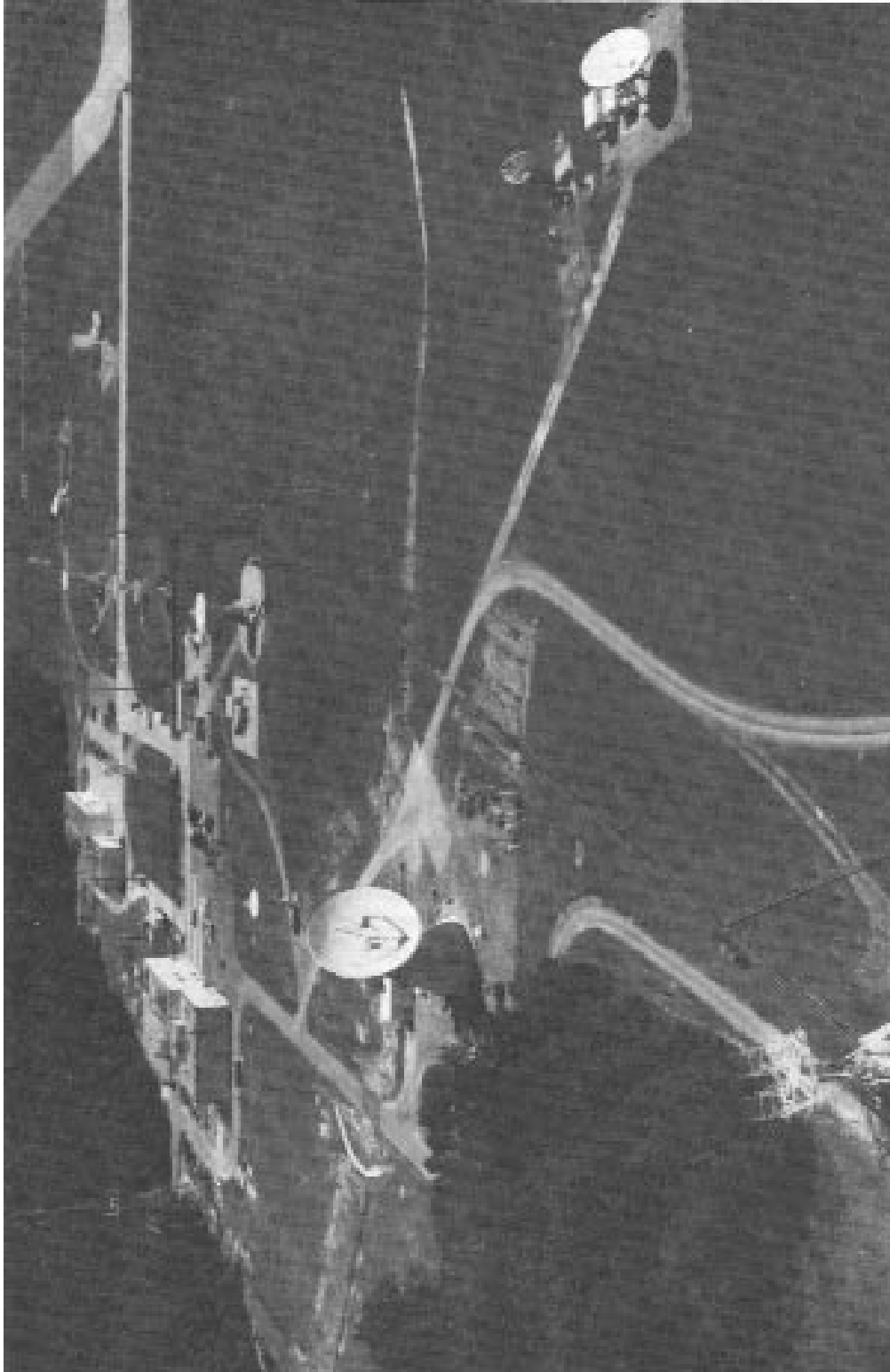


Figure 1 - 30: Fixed TM & Wallops Orbital Tracking Station Antenna Farm



**Figure 1 - 31: Range Telemetry Facility and Wallops Orbital Tracking Station (WOTS)**

## Mobile Telemetry Systems/Facilities

Mobile telemetry systems are designed to achieve rapid and simple installation in the field without permanent site preparations. Antenna types 1-10, Table 1-6, fit in this category. Additional details on Mobile systems are covered in section 1.2.2.6.3.

## Transportable Telemetry Systems/Facilities

Transportable telemetry systems are designed to provide temporary coverage at locations beyond that served by fixed facilities at Wallops. These systems require some permanent site preparation. Antenna types 11, 12, and 13 are in this category. These systems have metric tracking (Doppler and angles) and command uplink capabilities. The Transportable Orbital Tracking Station (TOTS) Systems were developed to provide multimission transportable low earth orbit spacecraft tracking capability. However, TOTS can also support vehicle and payload telemetry. Currently there are three fully automated TOTS systems. One is installed at Poker Flat Research Range. Tables 1-6 to 1-8 list the transportable systems specifications. Figure 1-32 shows a system configured for support.



**Figure 1 - 32: Transportable Orbital Tracking Station (TOTS)**

### 1.2.2.4 Communication Systems

WFF operates ground-to-ground, ground-to-air, air-to-ground, ship-to-shore, range intercom, and intra-station communications systems. These systems are composed of HF/VHF/UHF radios, cables, microwave links, closed-circuit television systems, command and control communications, frequency shift tone keying systems, high-speed data circuits, and the WFF NASCOM Network terminal. The cable plant supporting these communications systems includes extensive telephone, coaxial

cable, and fiber optics cables interconnecting the WFF facilities. Fiber optic cables are used to connect the Main Base, Mainland and Wallops Island areas.

Communications provide the means for managing operations at Wallops and communicating and coordinating operations with related operations in other geographic areas (e.g., ER, WR, Alaska). These communications systems are located at Wallops Island, Wallops Mainland, and Wallops Main Base, at remote stations, and mounted in vans for downrange and shipboard use. RF support services include spectrum management, frequency monitoring and interference control, search, recovery and homing systems, and meteorological information systems.

The Communications Receiver Facility is located on the Main Base in the Telecommunication Building (N162 in Figure 1-31), which houses the receivers, recorders, patching panels, command/destroy monitors and recorders, and the supporting ancillary equipment.

The receiving antennas are mounted on towers and poles in the immediate area. Worldwide reception is possible. The Frequency Monitoring and Interference Control facilities are co-located with the Communications Receiver Facility.

The Communications Transmitter Building is located just to the north of and inside the mainland entrance to the island facility. The transmitting antennas are mounted on top of the building and on towers and poles in the immediate area. An auxiliary power generator for the redundant command/destroy and communications systems is located in an adjacent building at this facility.

#### **1.2.2.5 Command Destroy Systems**

Ground-based Command Destroy Systems provide ground control of certain rocket and payload functions for flight safety and/or other command purposes. The range user can use these systems to command payload functions, as necessary, within range limitations.. The information provided in the following sections is representative of the support capability provided by WFF for commercial launch operations. Command system resources are subject to change due to mission requirements, revisions and modifications and new technology.

##### **Fixed Command Destroy Systems**

These systems are located just to the north of, and inside, the Mainland entrance to the island facility (See Figure 1-27). Each permanent system consists of two Radio Transmitting Sets with omni-directional and single-helix as well as quad-helix antennas. Each transmitter has an RF power output of ~1000 watts in the frequency range of 406.0 to 549.0 MHz. There are two fixed command systems located on the Mainland. These systems provide command coverage until impact,

orbital insertion, or the vehicle no longer endangers the public. An electronic switch between the WFF active command site and the Bermuda command site occurs at a predesignated time or elevation angle. This handover allows the safety officer to maintain control of the vehicle to the extent required by the mission rules. Rockets and payloads up to those in low earth orbit can be effectively commanded if they are within line-of-sight of the transmitter.

A fixed system (See Table 1-10) consists of two subsystems connected in a fail-over arrangement. If the primary subsystem fails, or if the RF power output falls below a predetermined level, fail-over is automatically initiated. The redundant subsystem then assumes control of the Command/Destruct function.

**Table 1 - 10: Wallops Fixed Command/Destruct Systems**

Transmitters			Antennas		
Type	Frequency	Power	Type/Control	Gain	Polarization
(2) ALEPH CTS-100 1000 Watts	406-549 MHz FM IRIG Tones	*Commercial AC *Generator for redundant system	(2) Orbit quad-helix, radar slaved or manual control	18 dB	LHC
			(2) Omni	0 dB	Vertical

**Primary Command/Destruct Subsystem** - The Primary Command/Destruct Subsystem consists of an ALEPH CTS-100 Transmitting Set, an ANTLAB Quad-helix antenna and the necessary control circuits. The transmitter modulation can be controlled locally, or by remote control from the WICC. The transmitter and the antenna pedestal operate from commercial AC power. The primary antenna is slaved, by means of the radar data acquisition bus, to a radar selected to provide the most accurate position information on the rocket/payload being tracked.

**Redundant Command/Destruct System** - The Redundant Command and Destruct Subsystem (identical to the primary) is powered by a local generator so that, in case of a failure of commercial power during a mission, control will still be maintained over the rocket/payload. The Quad-helix antenna used with this subsystem is positioned manually using predetermined angle versus time information.

#### Mobile Command Destruct

The function of a mobile command destruct system is the same as a fixed system. The mobile systems are used to extend the range to accomplish required mission objectives or to establish a mobile range for launch support where there would otherwise be none. For example, a Mobile System may be deployed to the Coquina site near Cape Hatteras, North Carolina, to the Poker Flat Research Range, or to an

alternate site as required by the mission. There are two redundant mobile command systems that are each a part of a mobile range support system. The first system is the Mobile Range Control System (MRCS), which includes two Power Systems Technology 1000W Transmitters with Marconi exciters mounted in a C-130 container. The second is the Mobile Command Destruct System (MCDS), which includes two Henry Radio Company 1000W Transmitters and Marconi exciters mounted in a 20 foot trailer. This system supports launches in instances where all of the functions of a mobile range safety system are not required. Both systems can be transported by air, rail, or ship. They both will be discussed in more detail in the following section on Mobile Systems.

#### **1.2.2.6 Mobile Systems**

WFF has the capability to support launch campaigns at locations outside of the WFF range (worldwide). Mobile systems have been developed and used to provide radar, telemetry, command destruct, range safety displays and command and control functions in support of both suborbital and orbital missions. The predecessor to the MCDS was used at Poker Flat Research Range in support of *sounding rocket (AF Talos M6 launches) as well as the Minisat mission from the Canary Islands*. The new (1996) mobile system consists of the MRCS trailer (mobile range control), a Telemetry Van (downlink data from the launch vehicle), and a Radar Van (launch vehicle tracking data). Figure 1-33 shows a line art drawing representative of the mobile configuration. The exact configuration depends on the launch user requirements and safety considerations as well as the launch site location, vehicle characteristics, and flight profile. The following paragraphs provide greater detail on the individual components that comprise a mobile system.

##### **1.2.2.6.1 Mobile Range Control System Trailer**

The WFF Mobile Range Control System, developed and upgraded in 1996, is enclosed in a 48 ft. C-131 container (see Figure 1-34). It contains a display system identical to the system in the Wallops Integrated Control Center. This new display system is part of the “mobile range safety real-time interactive impact prediction system” (MRTIIPS) (see Figure 1-35). As the figure shows, the MRTIIPS is actually three consoles in one. Each section, IIP#1, data quality control console (DQC), and IIP#2, is approximately six feet long. The overall system is nearly 20 ft long. During operations, two operators will sit at each of the three consoles.

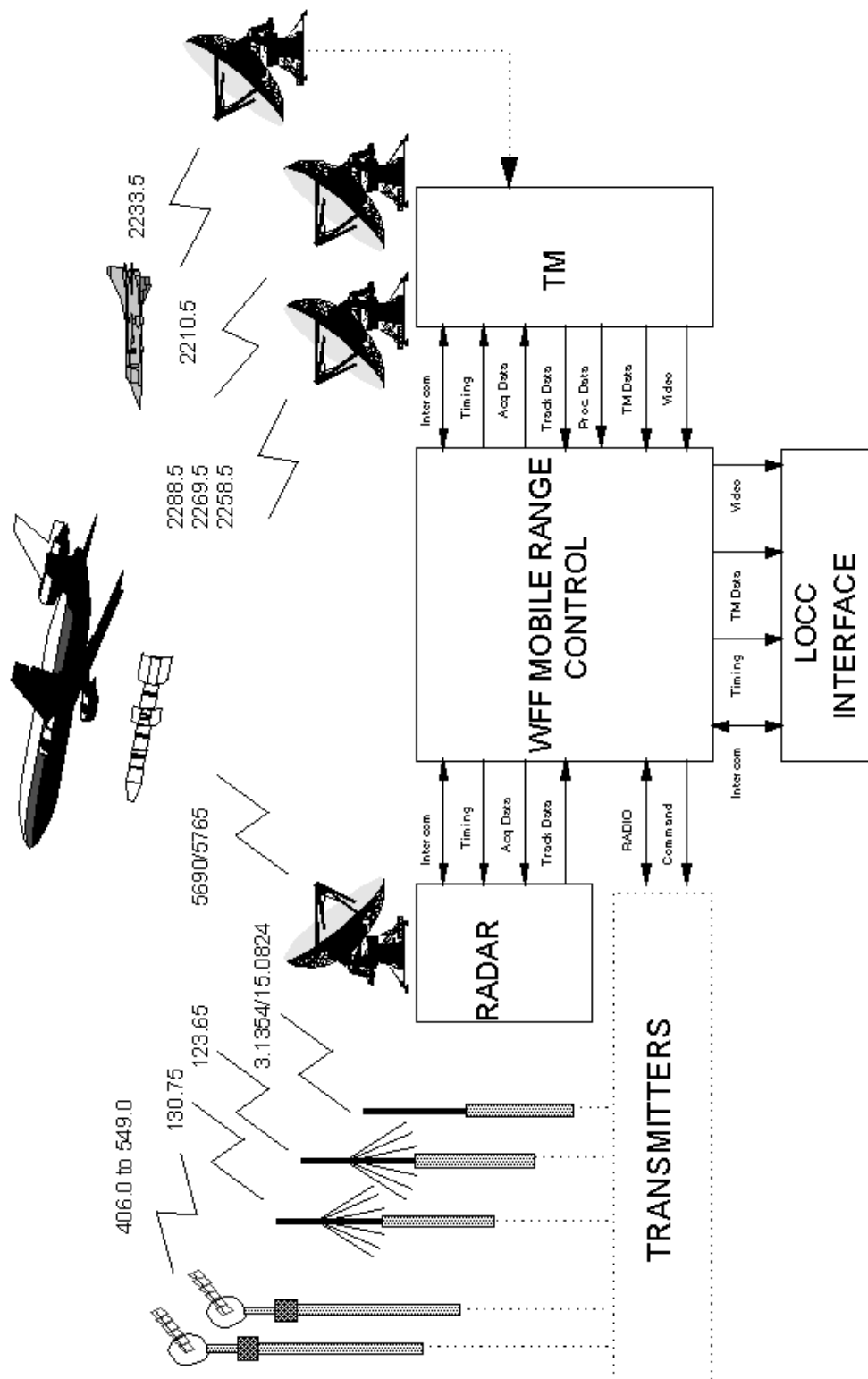


Figure 1 - 33: WFF Mobile Instrumentation Configuration



**Figure 1 - 34: Mobile Range Control System**

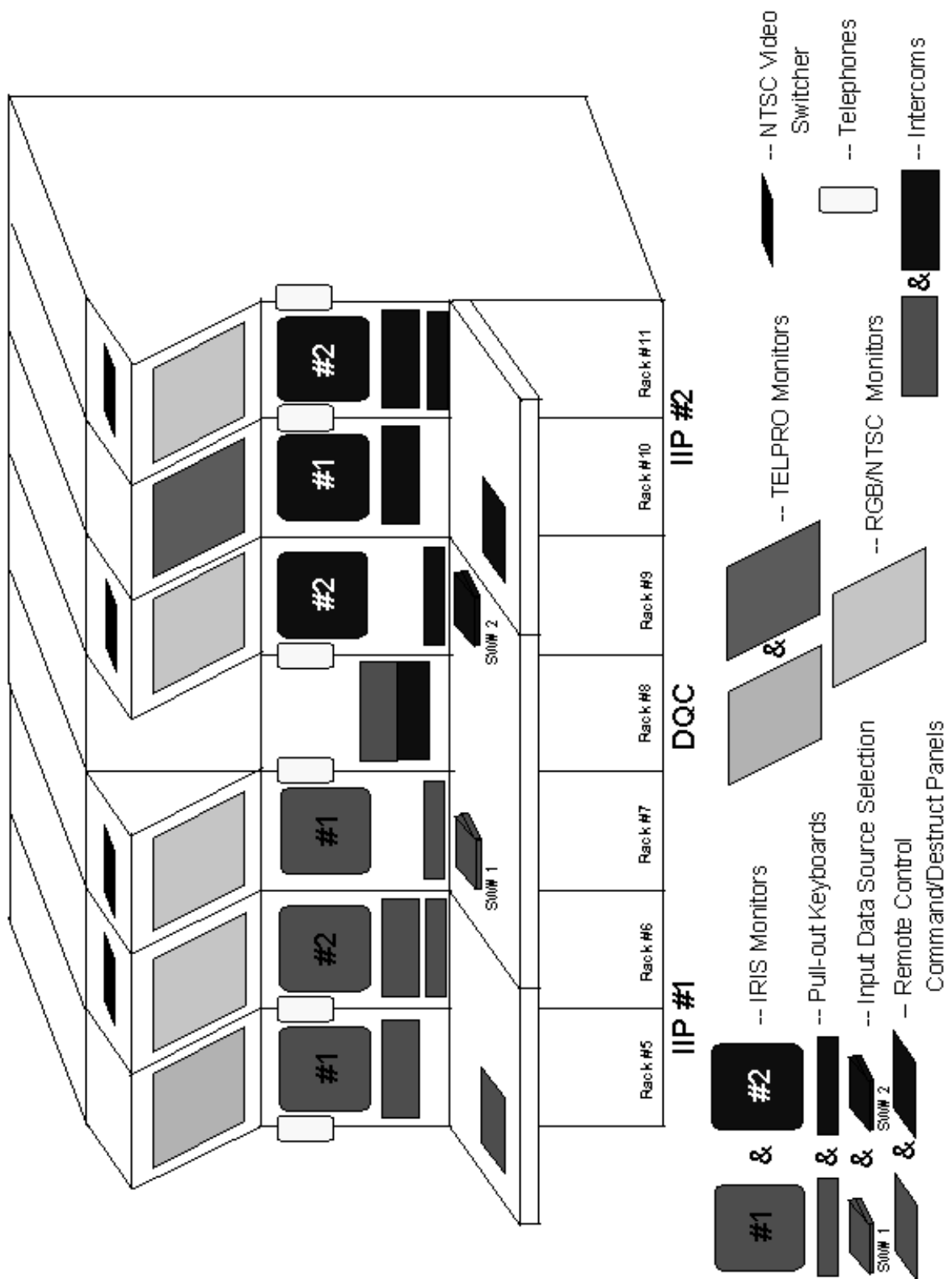


Figure 1 - 35: Mobile Range Safety Real Time Instantaneous Impact Prediction System

The following description is an example of how the display systems may be used, actual use varies from mission to mission depending on specific requirements. IIP#1 and IIP#2 are identical, independent console systems with #1 designated as prime and #2 as backup. The entire missile flight safety mission could be accomplished from either console. The panels on the shelves of IIP#1 and IIP#2 contain the arm and destruct buttons and the monitoring system for the missile flight destruct system. On the inclined portion of these consoles are the intercom control panels bounded on each side by a telephone. The six displays on the vertical surfaces are Iris displays. The vertical displays labeled #1 on both of the IIP consoles are identical in what is programmed as output. Both show multi-scale IIP trajectory data in the plus count. The #1 Iris display on both consoles may also show orbital prediction data after orbital insertion stage burnout. This display shows whether the vehicle is capable of reaching orbit, based on the burnout parameters and the known trajectory data. The #2 vertical displays on both IIP consoles can be switched to one of four different display formats.

During the plus count, the #2 display on IIP#1 may show nozzle pressure versus time or pitch and yaw versus time. During pre-mission support, this display may show flight termination system (FTS) data, safe and arm system status, link data, command receiver battery voltage, and AGC levels. The #2 display on IIP#2 may show velocity versus time, altitude versus ground range, flight elevation angles versus flight azimuth angles, or present position data, e.g., latitude and longitude, and altitude versus ground range. The six monitors located across the top of the system are 11 inch video monitors. The leftmost on IIP#1 is fed by TELPRO #1 and the leftmost on IIP#2 is driven by TELPRO #2 (see the Telemetry section for an explanation of the TELPRO systems). The right hand display on each IIP console is configured to show channels of switched video.

A video presentation of the TELPRO PC system data and additional telemetry data are also displayed on the center DQC. User PC data (normally telemetry), inertial navigational system (INS) state vector data, and Global Positioning System (GPS) satellite data are also displayed on the video monitors on the center console. Available GPS data includes the number of satellites being tracked, state vector timing information, and the health and status of the GPS system. On the DQC console, the switches SW#1 and SW#2 control which real-time sources are available for display. Switch #1 controls the IBM Master computer #1 and switch #2 controls IBM Master computer #2. The inclined panel on the DQC houses the video switch panels that control the output to the video displays on all three consoles.

Figure 1-36 is a flow diagram for the MRTIIPS. The top section of the figure identifies the flow of data and timing into and out of the telemetry computers and displays. The subsequent blocks identify the flow of data and timing to/from IIP System #1, the DQC console, IIP System #2, and their related real-time computers and display systems. Inputs to IIP System #1 are first fed to the IBM Master

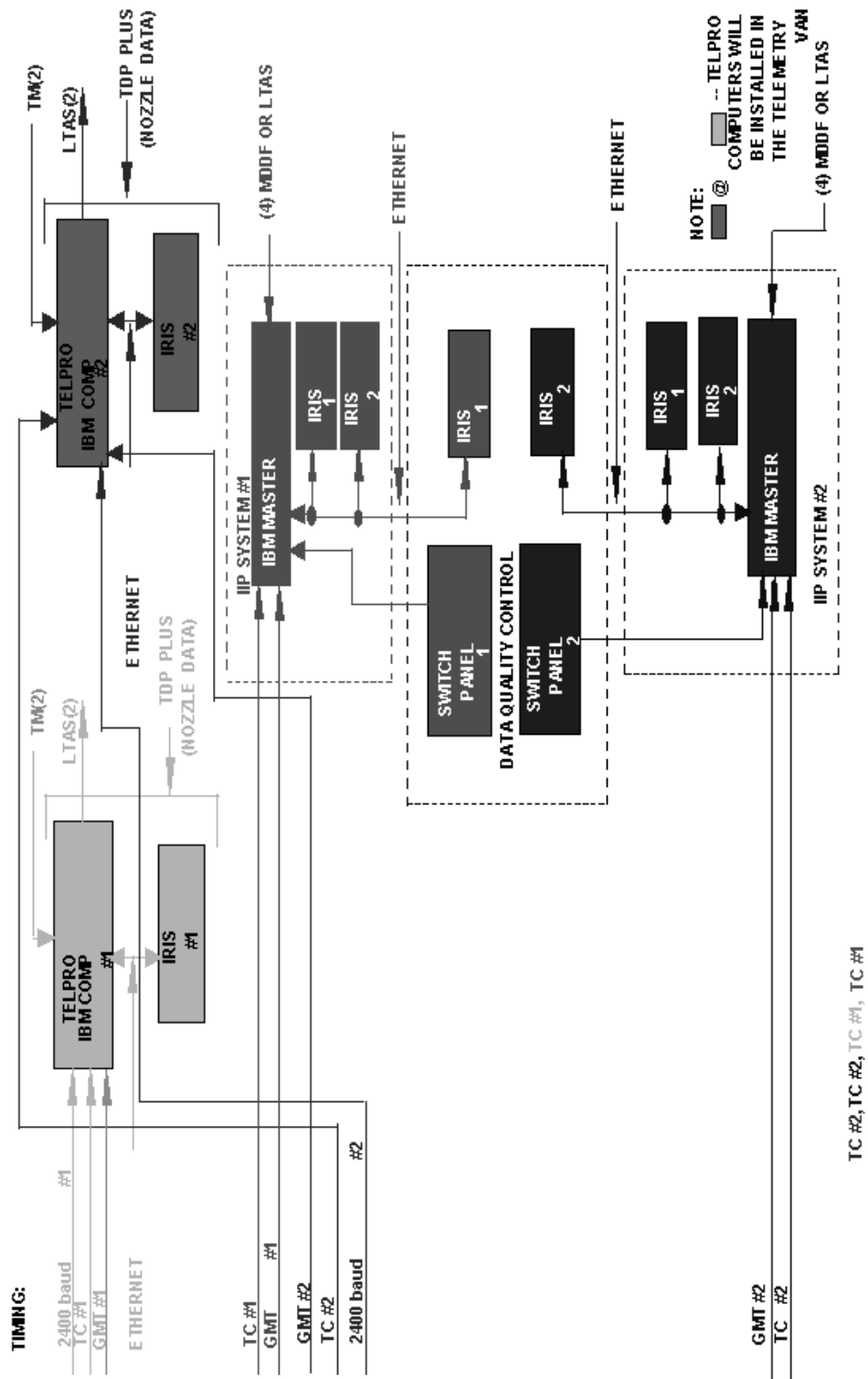


Figure 1 - 36: Timing and Data Flow for MRTIIPS

computer #1. These inputs include Time Code Generator (TCG) #1, Greenwich Mean Time (GMT) #1, and Minimum Delay Data Format (MDDF) or Launch Trajectory Acquisition System (LTAS) data. The TC input is 10 pps timing data generated by an ASCII Time Code Generator. This timing data is a backup should the normal GMT source (the GPS receiver and communications lines) fail after launch. Prior to launch, this data is ignored. The GMT timing data is down linked from the GPS satellites and fed to the real-time system through the GPS receiver. Four sources of MDDF or LTAS data can be accepted by the IBM Master computers. The MDDF data is radar range, azimuth, and elevation data. Data from each radar is a separate MDDF source. LTAS data is generated by the TELPRO IBM computers at the telemetry site. This data consists of earth centered position data in  $x$ ,  $y$ , and  $z$  and velocity data in  $\dot{x}$ ,  $\dot{y}$ , and  $\dot{z}$ . Output of the IBM Master is onto the ethernet where it is picked up by the Iris display systems. Separate sources of data are fed to the #2 IBM Master computer in IIP System #2.

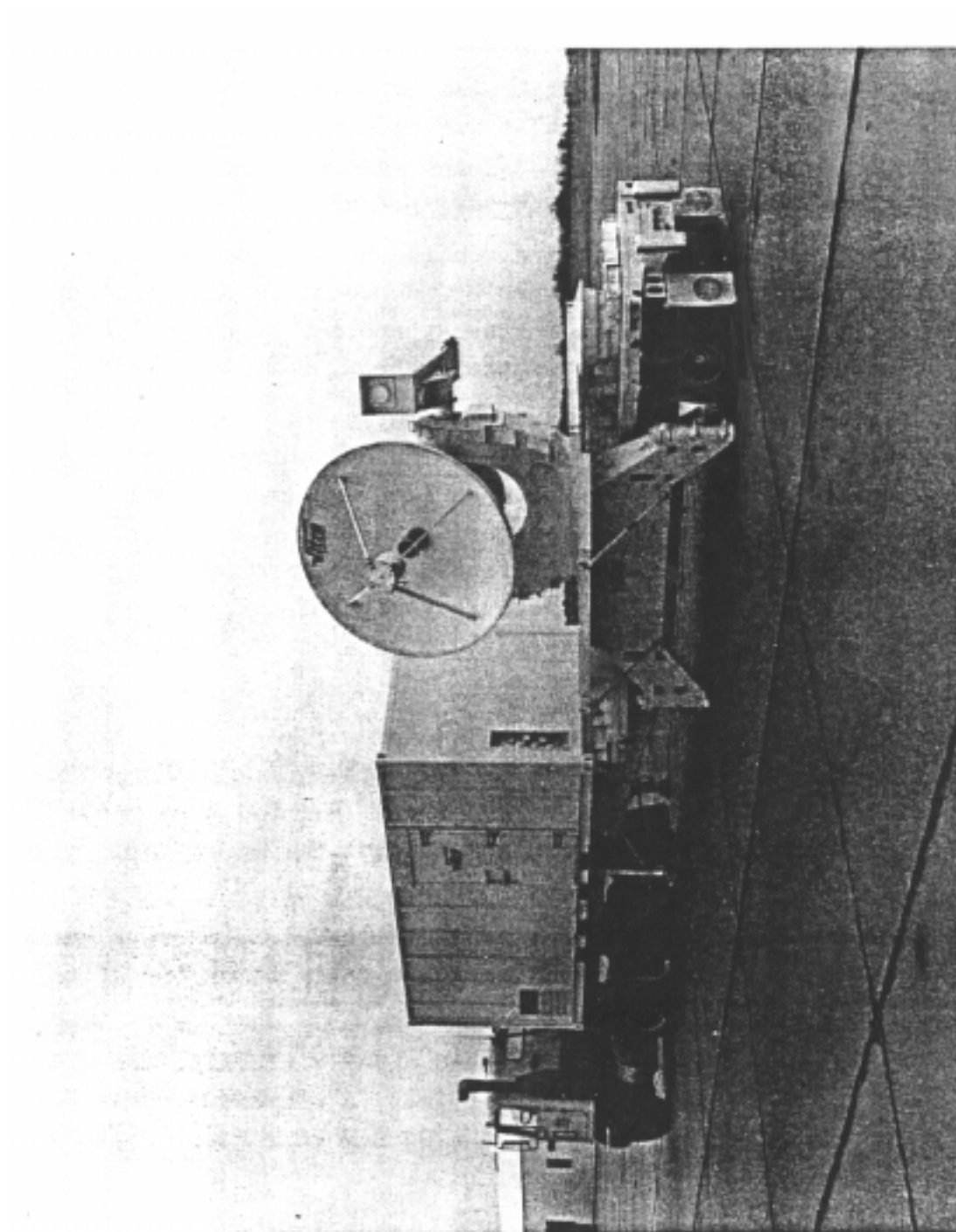
#### **1.2.2.6.2 Mobile Radar Systems**

Four C-band radars operating in the 5400 - 5900 MHz range are available to support off-site operations. Three are mobile RIR-778Cs located at WFF and listed in Table 1-6. The fourth is a transportable RIR-778C currently located at Poker Flat Research Range. The mobile systems have eight foot antenna's mounted on a flatbed trailer; whereas the transportable system has a 12 foot antenna mounted on a pedestal attached to a concrete pad. The pad for the 12 foot pedestal must be established at each new support location. The eight foot antennas on the mobile systems provide 38 dB gain and beacon track out to ~ 3,745 Kilometers (KM); while the 12 foot antenna on the transportable system provides beacon tracking range of 60,000KM. Figure 1-37 shows an example of a typical mobile radar system at WFF. These radars may be transported by land carrier or ferried by air, sea, or rail.

The radars provide continuous, accurate, spherical-coordinate information on targets being tracked. Each radar tracks in either the skin or beacon (transponder) mode providing trajectory data for real-time display/evaluation and recording.

Co-located on the radar's pedestal is a television camera and optics assembly (see Figure 1-37). This optical system can produce quality pictures under lighting conditions ranging from cloudy, moonless nights to bright, noontime sun. Because of the radar's co-located optical system, either optically-derived angle data or derived azimuth, elevation, and range data from the radar can be provided.

The radar console and display subsystem located in an equipment shelter contains all the controls and indicators required for radar operation and calibration. System calibration is accomplished in one of two ways, star calibration or electronic boresight calibration. Star calibration is the most accurate method. The electronic boresight is mounted on a tower at a fixed distance from the radar. It can be operated in skin or



**Figure 1 - 37: RIR-778C Radar System in the Travel Mode**

beacon mode to calibrate the system and to provide an accurate standard to verify the radar's mission readiness.

#### **1.2.2.6.3 Mobile Telemetry (TM) Systems**

The mobile TM site performs the TM functions of data acquisition, tracking, recording, playback, and quick look data reporting (through real-time or playback). Like the range safety trailer the TM system is installed in a 48 foot C-130 container set up to accommodate user requirements.

There are numerous mobile telemetry system configurations that can be assembled to support alternate launch sites around the world. These configurations are made up of the components shown in Tables 1-6, 1-7, 1-8 and 1-11. Included are various antenna systems, pad mounted or stand alone, which can be assembled with four different vans. Antennas vary in size from ~6 to 26 ft (see Table 6). All systems support S-Band TM in the 2200-2400 MHz range. In addition, other assets support L Band (1650-1710 MHz), L Band (1435-1540 MHz), and P Band (215-260 MHz).

In general, WFF telemetry vans can be configured with various antenna configurations to satisfy mission requirements.

Telemetry systems are currently installed at PFRR. These systems could be moved to support operations from other locations. Because these antennas are pad-mounted, the new location would require the installation of a pad on which the antenna pedestal would be mounted.

Several systems are self-contained units with six foot parabolic antennas. They are compact, relatively easy to assemble, test, and certify. These systems are used to support the prelaunch portion of an operation. They have a broader beamwidth and are good systems to use for early acquisition.

TM data is processed in the telemetry van by the TELPRO computer systems. The TELPROs output video data which is fed to a video switch for display. TM data is digitally processed and graphically displayed locally in addition it is routed to the mobile MRCS for display in real-time.

**Table 1 - 11: Miscellaneous Telemetry Systems**

**TRADAT V Telemetry System**

Antenna Type	Frequency	Remarks
Tradat V Trajectory Data System. One single ten-turn helix antenna.	FM/FM	<ul style="list-style-type: none"><li>• The light-weight PCM ranging system provides trajectory data for vehicles such as sounding rockets or balloons launched at remote sites where radar sets are not normally available.</li><li>• The antenna is normally attached to the telemetry antenna and interfaced with the host's autotrack controller system and transmits to an airborne PCM receiver/transmitter.</li></ul>

#### 1.2.2.6.4 Mobile Command Destruct System

The mobile command destruct system (MCDS) was upgraded to be a fully redundant mobile command system. It is used to uplink command signals to vehicles being launched from remote sites or as a backup in support of the Wallops Mainland system. Generally, these signals are for the purpose of command destruct; however, the MCDS system can also be used to uplink the command for payload deployment or other required vehicle functions. The system is remotely controlled by the RSO at WFF during flight. Data lines connect the system to the center for remote command functions, TM, and radar data. The MCDS is composed of two Henry Radio Company transmitters, a minimum of two antennas (either quad helix antenna with a 20 degree beamwidth and 18 dB gain, an omni with 360 degree coverage, or a single helix antenna with a 60 degree beamwidth and a 12 dB gain), and associated equipment. Each transmitter has an RF power output of ~1000 watts in the frequency range of 406.0 to 450.0 MHz. The transmitters are connected in a fail-over arrangement and mounted in a mobile van (See Figure 1-38). Transmitter modulation can be controlled locally. Frequency monitoring is also accomplished by personnel and equipment in the van to guard against radio frequency (RF) interference. See Table 1-12.



Figure 1 - 38: Exterior View of the MCDS 20 foot trailer

**Table 1 - 12: Mobile Command/Destruct Systems**

Transmitters

Antennas

Type	Frequency	Power	Type/Control	Gain	Control	Power	Features
(2) PST Power Systems Technology	406-450 Mhz	1000W	(2) Quad Helix Omni or Single Helix	18 db 15 db or 12db	PC Slaving System/ manual override	Build-in UPS	Fail-over transmitters. One hour set up at site if two compatible power sources available. Two antennas for redundancy.
(2) Henry Radio Company	406-450 Mhz	1000W	(2) Quad Helix Omni or Single Helix	18 db 12db	In 6M/20 ft shelter	Build-in UPS	Fail-over transmitters. One hour set up at site if two compatible power sources available. Two antennas for redundancy.

- Notes: 1. Mobile systems can use several antenna combinations.  
2. All helix antennas are left-hand circular polarization.

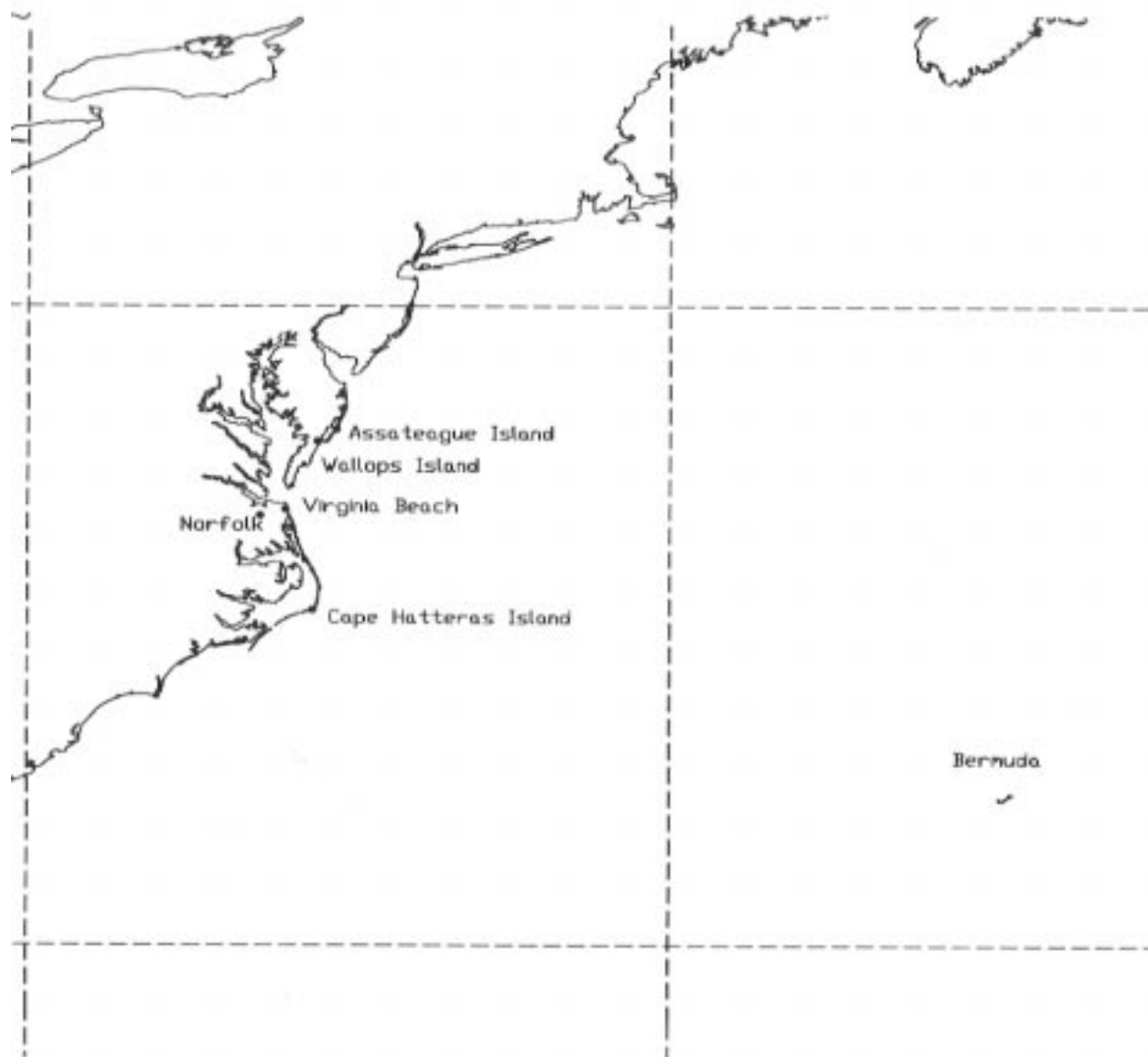
### 1.3 WFF COMMERCIAL VEHICLE SUPPORT CAPABILITY

Vehicles launched from Wallops Island are restricted to certain launch azimuths because of the populated land masses. The specific land masses affecting vehicle flight are: Assateague Island to the north, Cape Hatteras, the Bahamas, and South America to the south, and Bermuda, Europe, and Africa to the east (See Figures 1-9, 1-39 and 1-40). Specifically, risk criteria may not exceed a casualty expectancy of  $E_c = 1 \times 10^{-6}$ . How close to the continental US or any populated land mass a vehicle may fly is affected by its flight profile and explosive characteristics due to destruct action, impact, or catastrophic events. This can vary significantly by types of vehicles and even among flights of the same vehicle depending on payload and other vehicle configuration differences. The destruct lines shown in Figure 1-40 are representative of those for the southerly launch of an orbital vehicle/payload. The destruct lines are constructed to protect the associated land mass, its public property, and civilian population. Flight azimuths to the north are generally limited, because of Assateague Island. The North Carolina Outer Banks (Cape Hatteras) limit the southern azimuths. In general, launch azimuths between  $90^\circ$  and  $160^\circ$  can be accommodated depending on impact ranges. Launches perpendicular to the shoreline are on an azimuth of  $135^\circ$ . For most orbital vehicles, the nominal limits translate into orbital inclinations of between approximately  $38^\circ$  and  $60^\circ$  (See Figure 1-9).

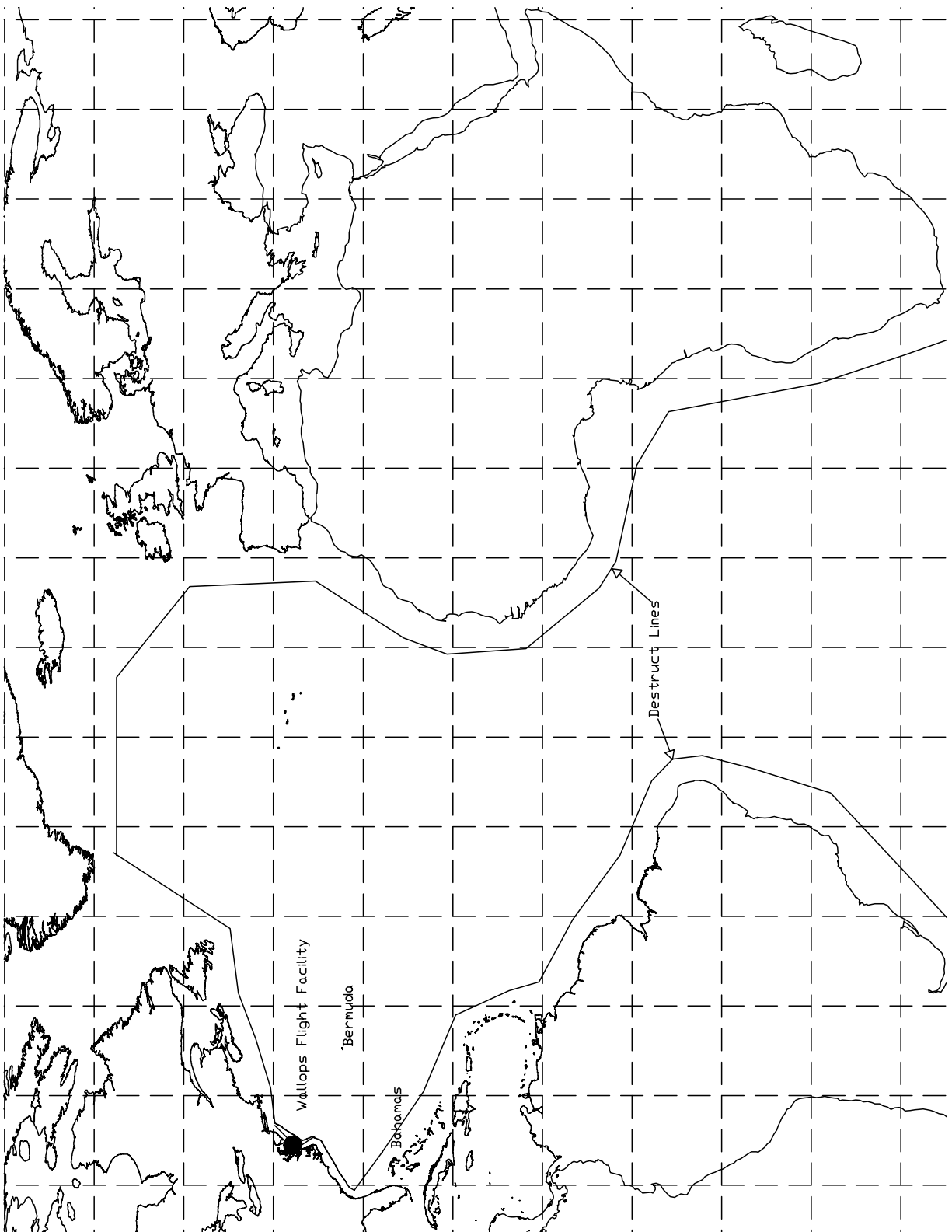
Trajectory options outside of these launch azimuths, including polar and sun-synchronous orbits, can be achieved by inflight azimuth maneuvers. Azimuths as low as  $45^\circ$  may be flown via a dogleg flight profile. This flight profile requires the vehicle to fly a launch azimuth of  $78^\circ$  or greater until the vehicle impact point is greater than 5 NM downrange. Azimuths greater than  $130^\circ$  may be approved by flight safety depending on stage impact points and casualty expectations associated with the impact and overflight areas. Each request is evaluated on a case-by-case basis.

WFF will protect Bermuda from a land impact no closer than 30 NM. Vehicles whose 3 sigma stage impact areas would infringe on the limit specified by this agreement are not allowed.

The overflight dwell time (the time that the IIP is over land) over South America or Africa is typically 6 - 10 seconds. The longer the dwell time, the longer the exposure, and the more risk there is to the population. Hazard analyses are conducted, as required, to determine the hazard, and modifications are made to the flight profile if dwell times exceed these figures. The limit on vehicle size at WFF is determined by the associated flight control hazard area, a radius of approximately 10,500 feet *is* used as a guideline, however, evacuation of non-government property may be acceptable to increase this hazard area if risk criteria is satisfied.



**Figure 1 - 39: Wallops Flight Facility Coastal Limitations**



**Figure 1 - 40: Wallops Flight Facility Overflight Areas & Destruct Limits**